FOSSIL PLANTS FROM BOLIVIA AND THEIR BEARING UPON THE AGE OF UPLIFT OF THE EASTERN ANDES.

By Edward W. Berry,
Of the Johns Hopkins University, Baltimore.

INTRODUCTION.

The present contribution includes a description of the fossil plants from two well-known localities in Bolivia—the copper district of Corocoro and the silver and tin district of Potosi—both classic localities that have been worked since the sixteenth century. The rather definite results regarding the age of these deposits has not only an important bearing on the time of mineralization in these regions, but is of the greatest value in indicating the period of elevation of the Andes, which is shown to be much later and more profound than has hitherto been supposed. This study is based upon material collected in 1915 by Profs. J. T. Singewald, jr., of the Johns Hopkins University, and Benjamin L. Miller, of Lehigh University. The types and figured specimens have been presented to the United States National Museum. A discussion of the results of this study is followed by a description of the flora, and by an account of a new species of Brachiopod contributed by Prof. Charles Schuchert, of Yale University.

PRESENT PHYSIOGRAPHY AND CLIMATE.

A brief outline of the present physiography, geology, and climate of Bolivia are necessary to an understanding of the bearing of the fossil floras discussed in the following pages on the geological history of the region.

Although lying wholly within the Torrid Zone the combination of elevation, mountain barriers, and prevailing winds has had a most profound influence on the climate, and consequently upon the flora and fauna. Except for certain transverse and irrigated valleys and the relatively low and barren Coast Range the country bordering the Pacific (now belonging to Chile) is a desert of shifting sands. This is bounded on the east by the Western Andes or Cordillera Occidental, which parallels the coast at a distance of from 50 to 100 miles.[1]

[1] The relatively low Coast Range is omitted, as it is of no importance in the present connection.

The western Andes consist chiefly of Mesozoic deposits, together with innumerable lava flows and ash beds of the great series of high volcanoes, whose greatest activity appears to have been reached in very late geologic times. The Cordillera Occidental, with many peaks between 19,000 and 21,000 feet in altitude, forms the western ramparts of the high Bolivean plateau or "altaplanicie," which extends from the Vilcanota massif of Peru southward to the Argentine frontier—a distance of about 500 miles and with an average width of about 80 miles. It has an average elevation of between 12,000 and 13,000 feet, and is bleak and inhospitable in the north (the "puna"), and arid and barren toward the south—the desert of Lipez—with saline depressions, and ridges and peaks rising through the flat mantle of Pleistocene and Recent deposits.

The eastern ramparts of the "altaplanicie" are formed by the somewhat fanned-out chains of the eastern Andes or "Cordillera Real," consisting largely of folded Paleozoics with granitic cores and other igneous intrusives, in part at least of late Tertiary age, forming a series of high peaks, a number of which reach above 21,000 feet. It is about 250 miles from the western range of the Cordillera Real to the Sierra de Cochabamba and the Sierra de Misiones, which form the eastern boundary of this imposing mountain mass. It is in the midst of this extremely rugged montane country that Potosi rises to a height of 15,381 feet, surrounded on all sides by much higher peaks.

Three-fifths of the area of Bolivia lies east of the Cordillera Real, and forms a part of the Amazon and Paraguay drainage basins. The latter region consists of gently undulating forests, low alluvial grass-covered plains (llanos), great swamps, and flooded bottom lands.

Little can be said of the details of either the existing climate or vegetation of much of Bolivia. The lowlands east of the mountains, comprising the Provinces of El Beni, Santa Cruz, Chuquisaca, and Tarija, together with the eastern mountain valleys below 5,000 feet, are termed "yungas" (a climatic term) and have a humid tropical climate. The higher valleys of the eastern Andes between 5,000 and 9,500 feet, where they are situated so as to receive the moisture-laden northeast trade winds, have a subtropical character. Above 9,500 feet and up to 11,000 feet the climate is in general temperate and suitable for raising vegetables and cereals. Between 11,000 feet and 12,500 feet in the mountains, and consequently including the high plateau, is the "puna" or region of cold and aridity, with two seasons—a cold summer or autumn and a winter. The air is cold and dry and the growing season is too short for anything except oca (Oxalis) quinoa (Chenopodium), potato, barley, and coarse grasses.

Above 12,500 feet and extending to the snow line (about 17,500 feet) is the "puna brava," a bleak inhospitable region of shepherds and miners, and with arctic rosette plants and a few grasses.

POTOSI.

Cerro Rico de Potosi or Potosi Mountain lies immediately southeast of the town of Potosi in the northern part of the Province of that name, in the eastern Andes or Cordillera Real, which forms the eastern boundary of the high plateau of Bolivia. The mountain, which has a height of 15,381 feet, consists of a core of rhyolite surrounded by conglomerates, shales, and tuffs. Fossil plants are abundant in the latter on the northeast slope of the mountain and also in some of the mine tunnels.

Silver was discovered at Potosi in 1544, and mining for this metal and latterly for tin has been in operation for over 350 years. An account of the region has recently been published by Miller and Singewald,[1] who collected the fossils that are the basis of the present contribution.

COROCORO.

Corocoro is near the western edge of the high plateau (altiplanicie) of Bolivia in a group of low structural hills such as not infrequently project through the flat surficial deposits of the plateau. It lies a short distance south of the Arica-La Paz Railroad in the Province of La Paz, about 100 kilometers southwest of the town of La Paz and at an altitude of slightly more than 13,000 feet. It is about 2° north and 2° 40′ west of Potosi. The country rock is a thick and much faulted series of prevailingly red, gypsiferous and ferruginous shales, sandstones, and conglomerates. Copper has been mined at Corocoro since before the arrival of the Spaniards in the sixteenth century, and a general account of the district has recently been published by Singewald and Miller.[2]

AGE OF THE COROCORO ROCK.

Opinions regarding the age of this series have ranged from Carboniferous to Tertiary. These have not been based upon paleontologic evidence, however, since no fossils have hitherto been known from the series. Messrs. Singewald and Miller collected fossil plants from a sandy tuff northwest of Corocoro and obtained the cast of a footprint from a specimen collected by Fernando Dorian, manager of the Corocoro Copper Mines (Ltd.) along the railroad between Tarejra

[1] Miller and Singewald, Mining Conditions at Potosi, Bolivia. Eng. and Min. Journ., vol. 103, 1917, pp. 255–260.

[2] Singewald and Miller, The Corocoro Copper District of Bolivia, Eng. and Min. Journ., vol. 103, 1917, pp. 171–176.

and Corocoro. The latter, according to Prof. R. S. Lull, probably represents an Upper Triassic amphibian. Unfortunately the stratigraphic relations between the two outcrops is unknown, but there is no reason to doubt Professor Lull's determination or the possible presence of rocks of Triassic age in the vicinity.

The fossil plants are, however, of more immediate interest, since they occur in the horizon of the "vetas," and hence fix the age of the immediate country rock and mineralization as late Tertiary. While the fossil plants are neither abundant nor well preserved, sufficient species can be identified to fix the horizon as very nearly the same as that at Potosi, and hence determine the age of the copper-bearing rocks rather definitely as late Tertiary.

The plants which I have identified are the following: *Polystichum bolivianum, Acacia uninervifolia, Mimosa arcuatifolia, Mimosites engelhardti, Cassia ligustrinaformis, Copaifera corocoriana, Terminalia singewaldi.*

All but the last two are present at Potosi. The Copaifera and Terminalia are both represented by fruits. The latter is very similar to the not uncommon fruits of *Terminalia antiqua* from Potosi, and the leaflets of a species of Copaifera that might represent the same species as the fruits from Corocoro are present at Potosi. Thus the parallelism between the two floras is extremely close.

When a meager flora like that found at Corocoro is compared with a more extensive flora like that at Potosi, the age might differ appreciably, and yet the more common species of the larger flora might be expected to be present in the smaller. When, however, it is not only the commonest species of the larger that are found in the smaller, but also forms like the Polystichum found in a single specimen in both, additional indication of contemporaneity is afforded. Furthermore all of the Corocoro plants are represented in the modern flora by closely related species east of the mountains and all of the genera are still found in the same general region where climatic conditions differ from those prevailing at the present time on the high plateau of Bolivia. The latter region, because of its altitude and consequent coldness, and the aridity due to the interposition of the lofty eastern Andes in the path of the prevailingly eastern tradewinds, is practically treeless and in striking contrast with the conditions at the time the fossil flora was living in this region, all of the seven recorded species except the Polystichum being arborescent and some of them usually large trees. If the evidence for the Pliocene age of the Potosi flora is regarded as conclusive then there can be no doubt but that the Corocoro flora is also Pliocene, and this age is thereby established for the copper-bearing rocks of this mining district.

BOTANICAL CHARACTER.

The present contribution enumerates 85 different species of plants from Bolivia, of which 82 come from the tuffs of the historic Cerro de Potosi. Collections from these tuffs studied by Engelhardt in 1887 and 1894 resulted in making known 44 species of fossil plants, and Britton in 1893 added 11 species. The flora as at present known is remarkable for the great predominance of small individuals in it and for the large numbers and variety of its Leguminosae. It contains the representatives of 6 Pteridophytes (all ferns), 1 coniferophyte (a Podocarpus) and 75 angiosperms, of which 3 are Monocotyledons and the balance Dicotyledons. Of the latter there are 8 of doubtful affinities, 5 Gamopetalae, and 59 Choripetalae. The Dicotyledonae represent 41 genera in 20 families and 13 orders. The largest genus is Cassia with 10 species. The most abundant individual forms are *Myrica banksioides* and *Calliandra obliqua*. Much the largest order is the Rosales, represented by the families Saxifragaceae, Cunoniaceae, Mimosaceae, Caesalpiniaceae, and Papilionaceae, containing altogether 47 species, the great majority belonging to the last three families. There are 13 species of Mimosaceae representing the genera *Acacia*, *Inga*, *Pithecolobium*, *Mimosa*, *Mimosites*, *Calliandra*, and *Enterolobium*. There are 17 species of Caesalpiniaceae representing the genera *Cassia*, *Caesalpinia*, *Caesalpinites*, *Copaifera*, *Bauhinia*, and *Peltophorum*. There are 12 species of Papilionaceae, representing the genera *Amicia*, *Machaerium*, *Dalbergia*, *Desmodium*, *Drepanocarpus*, *Aeschynomene*, *Sweetia*, *Lonchocarpus*, and *Platypodium*. There are thus 9 genera of Papilionaceae, 6 of Caesalpiniaceae, and 7 of Mimosaceae. No other families are represented by more than two genera and most of them have but a single genus present. Similarly all of the nonleguminous genera except *Myrica* and *Weinmannia* are represented by a single species.

There are three or four species of *Myrica* in the fossil flora of Potosi, the only common and clearly defined of which is *Myrica banksioides* Engelhardt, and I am not sure but that *Myrica wendtii* Britton and *Myrica engelhardtii* Britton are not simply large and small variants of this species. *Myrica potosina* Britton is not a *Myrica*, and while *Myricophyllum*, species Engelhardt, is clearly distinct from all of the preceding and apparently represents a perfectly good *Comptonia*-like *Myrica*, it is represented by such incomplete material that little can be said about it.

Myrica is a very old generic type with a large number of fossil species, ranging in age from the Mid-Cretaceous to the present. The still existing species are relatively few in number, are widely scattered geographically, and represent survivors from a Tertiary cosmopolitan distribution.

Myrica has about 35 existing species and is widely distributed in the warmer parts of both hemispheres. Although we commonly think of *Myrica* as a temperate type, the bulk of the existing species are decidedly warm temperate and upland tropical types. The subgenus *Morella* comprises nearly all the existing species, and its area of distribution includes southeastern Asia from Japan and China through the East Indies. In Africa it extends from Abyssinia to Madagascar and the Cape throughout the eastern watershed. In Europe a single species extends from southern Portugal to the Azores and Canaries. In America one species (*carolinensis*) reaches northward to Nova Scotia; another (*cerifera*) extends northward to Maryland; and two species on the Pacific coast extend the range northward to Oregon. The balance of the species occur throughout the Antilles, Central America, and northwestern South America. Only one species, usually considered as a subgenus, is cold temperate in its distribution. The latter, *Myrica gale*, ranges from Kamchatka to Lappland, Britain, and western France in the Palarctic region, and from Newfoundland to southern Alaska in the Nearctic region, where it extends southward to Virginia. Thus eastern North America is the only region where there is any considerable overlapping of the two subgenera. These features are brought out on the accompanying sketch map, and the conclusion is reached that *Myrica gale* is a late Tertiary or Pleistocene Holarctic radiation from what was a distinctly warm temperate group of species, and this conclusion is more or less corroborated by the geological history of the genus—the bulk of the fossil species representing the *Morella* section of the genus, or the allied genus *Comptonia*, which is sometimes made a third subgenus of *Myrica*, and which has but a single existing species of eastern North America, although cosmopolitan in the Tertiary. *Myrica* is not uncommon in the warm temperate and subtropical Tertiary coastal floras of southeastern North America.

There are several shrubby species of *Myrica* in the Inter-Andean region of Central Peru (*Myrica variibractea* De Candolle, *M. weberbaueri* De Candolle) which range upward to 3,000 meters. Whether these extend southward as far as the Potosi region I do not know, but *Myrica xalapensis* is found in eastern Bolivia in the Santa Cruz region, and is doubtless more wide ranging than the meager records indicate.

The fossil ferns are too few and incomplete to merit any special comment. The grasses are represented by three types, and the presence of flowering scales of a species of *Festuca* is notable, since the known fossil grasses usually comprise stem or leaf fragments. The fragment of a palm, while too incomplete to arouse botanical interest, is important ecologically and serves to establish the presence of this essentially tropical type in the flora. Genera not otherwise

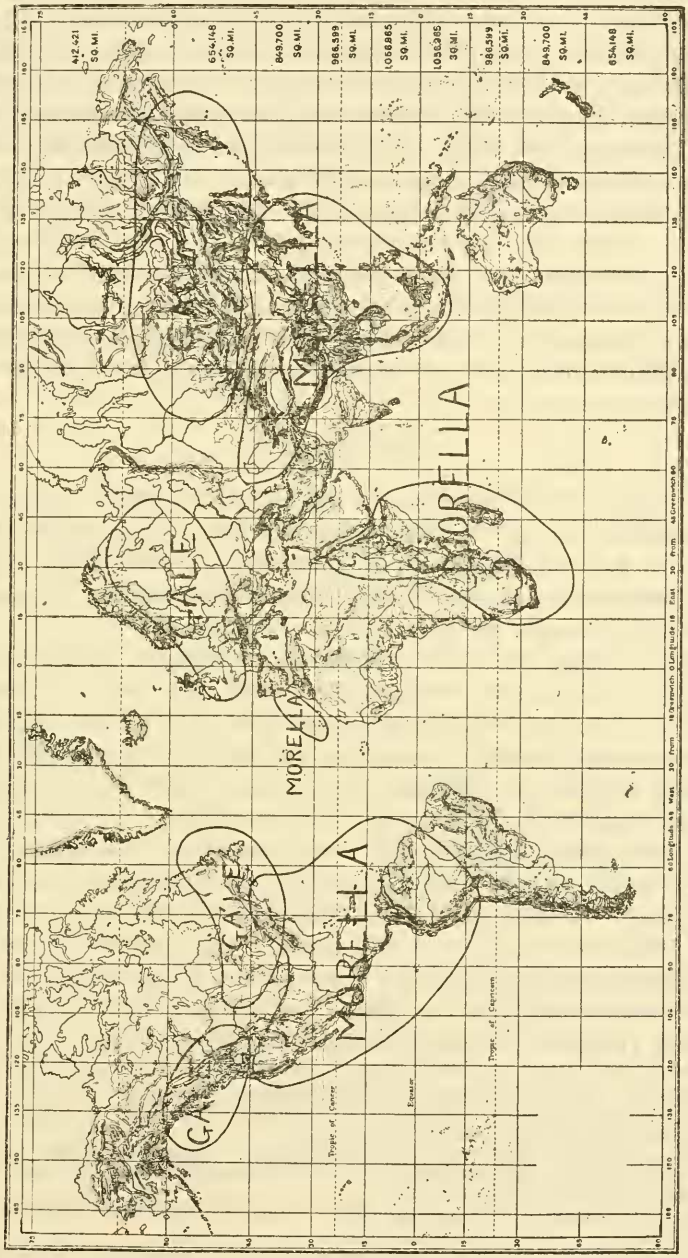

FIG. 1.—MAP SHOWING THE EXISTING DISTRIBUTION OF THE SUBGENERA OF MYRICA.

known in the fossil state and all South American in the existing flora include *Ruprechtia* of the Polygonaceae; *Escallonia* of the Saxifragaceae; *Enterolobium* of the Mimosaceae; *Peltophorum* of the Caesalpiniaceae; *Amicia*, *Drepanocarpus*, *Aeschynomene*, *Sweetia*, and *Platypodium* of the Papilionaceae; *Porlieria* of the Zygophyllaceae; *Myrteola* of the Myrtaceae; and *Cuphea* of the Lythraceae. The family Combretaceae is represented both at Potosi and Corocoro by the characteristic fruits of species apparently belonging to the Diptera section of Terminalia—an old genus with a large number of modern tropical and subtropical species and still present in eastern Bolivia. In lieu of a more extended botanical analysis the reader is referred to the accompanying table of fossil species with their existing relatives. This, together with the facts introduced in the systematic account of the fossils, will serve to complete the botanical picture and also supply the pertinent facts regarding the geological history of the various fossil types.

CORRELATION.

The number of Tertiary plants described from South America is inconsiderable, so that there is no means of direct comparison between the Potosi flora and other fossil floras except with those that are remote geographically, and such comparisons become increasingly hazardous the nearer the approach to the Recent.

Tertiary plants have been known from southern Chile (Coronel) since 1891,[1] and a flora of apparently the same age is present at several localities in the extreme southern part of the continent.[2] These all appear to fall in the earlier Tertiary, De Lapparent regarding them as Eocene (probably Sparnacian) and Dusén, following Wilckens, regarding them as probably Oligocene. At the opposite end of the continent Engelhardt[3] has described a considerable flora from Colombia (Santa Ana, Cáucathale) and Ecuador (Tablayacu, Loja Basin). These are simply designated as Tertiary by Engelhardt, Wolf,[4] and others. From certain resemblances to the flora from Panama recently studied I am disposed to regard the Loja coals as the same age as the plant bearing beds of Panama, which are either Oligocene or early Miocene, and in any event much older

[1] Engelhardt, H., Ueber Tertiärpflanzen von Chile, Abh. Senck. Naturf. Gesell., vol. 16, Hft. 4, 1891, pp. 629–692, pls. 1–14. Engelhardt, H., Bemerkungen zu chilenischen Tertiärpflanzen. Abh. Sitz. Naturw. Gesell. Isis in Dresden, 1905, pp. 69–82, pl. 1.

[2] Gilkinet, A., Quelques plantes fossiles des terres Magellaniques. Resultats voyage du S. Y. *Belgica* en 1897–1899, 1909. Dusen, P., Ueber die tertiare Flora der Magellansländer. Svenska Exped. till Magellansländerna, vol. 1, 1899, pp. 87–107, pls. 8–13.

[3] Engelhardt, H., Ueber neue Tertiärpflanzen Süd-Amerikas, Abh. Senck. Naturf. Gesell., vol. 19, 1895, pp. 1–47, pls. 1–9.

[4] Wolf, Teodoro, Geografia y Geologia del Ecuador, 1892. Wolf, T., and Rath, G. vom, Zeits. Deutsch. Geol. Gesell., vol. 28, 1876, pp. 391–393.

than the Potosi flora. I have heard of fossil plants in the lake beds of Saõ Paulo through von Ihering, who wrote me of collections having been sent to Kurtz at Cordoba some years ago, but these have apparently never been described. The only other South American Tertiary plants known to me, aside from the record of leaf impressions, apparently uncollected, on the island of Trinidad,[1] are the Pliocene plants from the province of Bahia (Brazil), briefly reported upon by Krasser[2] and Bonnet.[3] Ettingshausen at the time of his death had in preparation an illustrated account of this flora with autotypic reproductions of the related existing species, but this unfortunately was never completed.

It is obvious, then, that the familiar method of ascertaining the age of the Potosi flora by direct comparison with fossil floras of known age in the same general region or even on the same continent is impossible, and it is necessary to rely on a comparison of the Potosi flora with that found in the vicinity of Potosi and on the high plateau of Bolivia at the present time in order to get a measure of the differences in the environments between the two, and then to determine the degree of resemblance between the Potosi flora and that existing in any other part of South America at the present time, and to endeavor to deduce from these criteria its probable age.

It is perhaps needless to more than mention the existing flora at Potosi or on the high plateau near Corocoro since the rainfall is scanty and both regions are practically treeless and totally incapable of supporting the fossil flora found at these two localities. From a cursory study of Engelhardt's and Britton's determinations I long ago catalogued the Potosi flora as Pliocene, and when I began the study of the collections made by Singewald and Miller, the great resemblance of the majority of the forms, to be mentioned in detail in subsequent paragraphs, to those still existing in the rain forests of eastern Bolivia or to characteristic types of the Amazon Basin, led me to even consider these fossil floras as possibly as young as the older Pleistocene. I do not think that the resemblance to the recent flora east of the Andes is overestimated, but the remarkable discovery of a marine Brachiopod in the Potosi tuffs added another factor. It is obvious that the fossil plants could not have grown at Potosi or Corocoro had the front range of the Andes at that time been elevated sufficiently to precipitate the moisture-laden winds that come from the east. At the present time the eastern slopes of the Cordillera Real are very different climatologically and consequently

[1] Wall and Sawkins, Report on the Geology of Trinidad. Mem. Geol. Surv. Gt. Britain, London, 1860, pp. 35–52.

[2] Krasser, F., Konstantin von Ettingshausens studien über die fossile Flora von Ouricanga in Brazilien. Sitz. k. Akad. Wiss. Wien, vol. 112, Abh. 1, 1903, pp. 852–860.

[3] Bonnet, Ed., Contribution à la flore pliocéne de la province de Bahia (Brésil). Bull. Mus. d'hist. Nat. Année 1905, p. 510–512.

floristically from the western or leeward slopes and the plateau lands behind them. The first has almost daily rains and is forested to the timber line. The second are so dry that they permit the growth of only drought-resisting grasses and low scrub, and over very large areas there is no vegetation whatever. Consequently it might seem that a moderate reduction in elevation would have permitted some of the moisture-laden winds to pass and made possible the Potosi and Corocoro floras. When, however, it was found that the former was associated with a marine form, also of very modern aspect, it was realized that the change of elevation involved had actually amounted to about 2½ miles.

The admirable physiographic studies of Bowman in the Peruvian Andes,[1] as well as less detailed studies farther south, furnish distinct evidence of glaciation thought to be late Pleistocene because of the freshness of the deposits and the related topographic forms. Moreover his evidence of the profound erosion as indicated by the mature topography below the present rough summit topography leads him to regard the Andes as having undergone progressive elevation throughout the Tertiary, and he concludes that there has been a change of elevation in the late Tertiary amounting to about 5,000 feet.

It would seem then, that if the physiographic history of the region is correct, in even its broader outlines, the fossil floras are pre-Pleistocene in age. The Bahia Pliocene flora, previously mentioned comprises about 70 forms, none of which have been adequately described and none at all have been figured so that comparisons with the Potosi flora rest entirely upon names. Notwithstanding this difficulty it may be noted that the following genera, all of which should be determinable with reasonable certainty, are common to the Potosi flora and the Pliocene flora of Bahia: *Inga, Cassia, Copaifera, Dalbergia, Terminalia,* and *Weinmannia.* All are, of course, typical members of the tropical flora of the Amazon Basin and hence this agreement may be without any special significance. At the same time it is worth noting that if this resemblance is worth anything it tends to confirm the evidence independently reached by a comparison of the Potosi flora with the existing flora of tropical South America east of the Andes. That comparison may now be briefly sketched.

I have assembled in the accompanying table the fossil species in one column, the most closely related existing species in another column, and the range of the latter in a third column. Where the resemblance of fossil to living species was not extremely close or where I lacked material for adequate comparison I have named no existing species so that the resemblances are underestimated rather than adequately emphasized and the table is therefore much more

[1] Bowman, Isaiah, The Andes of Southern Peru. Amer. Geogr. Soc., 1916.

significant than similar tables ordinarily constructed by paleobotanists for like purposes. Thus of the 82 species of plants recorded from Potosi, after deducting the 16 indefinite forms referred to form genera such as *Antholithus*, *Carpolithus*, *Poacites*, *Phragmites*, *Palmophyllum*, *Pecopteris*, *Rubiacites*, *Cypselites*, and *Leguminosites*, 54 of the Potosi species out of the 66 remaining are so similar to living forms that in a majority of cases it would have done but little violence to the facts to have identified them as fossil occurrences of these existing forms. Without elaboration then it may be stated that the fossil flora is preponderantly modern in its aspect, and this similarity to the existing flora of the American tropics is too great to warrant considering the fossil flora as older than the late Tertiary. I know of no described flora as young as even the late Miocene that is as homogenous and does not contain some exotic elements or some genera that are not still found in the same general region. Summarizing, it may be noted that the Potosi fossil flora contains no species not closely related to still existing species, no genera not still found in the same general region, several genera not otherwise known fossil, and an abundant representation of relatively modern types and localized genera, as for example those of the Papilionaceae.

One has only to go eastward or northeastward a few hundred miles from Potosi to find what is essentially the same flora as that found fossil, existing, however, under climatic conditions quite different from those prevailing at the present time at Potosi or upon the high plateau of Bolivia.

Categorical conclusions regarding the exact physical environment of the fossil flora can not be deduced, but certain more general statements are warranted. The number of fossil forms definitely correlated with existing forms is 54. Forty-six of these fossil forms are represented in the existing flora of the Amazon Basin, and many of these extend greater or less distances into eastern Bolivia, such details as are available being introduced under the systematic description of the species. A number of these range northward to Central America and the Antilles and some are more characteristic of the Orinoco or northwestern part of the Amazon Basin than of that part in the latitude of Bolivia. In two or three cases where the existing species closest to the fossil is confined to this more northerly region, as in *Polystichum* and *Myrica*, these genera are represented in the existing flora of Bolivia by other species of the genus, material of which has not been available for comparison.

In the whole fossil flora enumerated comprising a representation of 85 species only the following can be regarded as Andean or West Coast forms: *Festuca*, *Escallonia*, *Amicia*, *Polystichum*, *Porliera*, *Euphorbia*, and *Myrtcola*. This is a relatively small number and of

these *Festuca*, *Escallonia*, *Polystichum*, *Porliera*, and *Euphorbia* are represented outside the Andean region, leaving only *Amicia* and *Myrteola* as typically Andean plants. Plants of extra-tropical climatic requirements in that they are montane forms and hence live under temperate temperatures or in arid situations include *Festuca*, *Escallonia*, *Amicia*, *Polystichum*, *Porliera*, *Euphorbia*, and *Myrteola*, the same genera previously enumerated as Andean in character. *Polystichum* and *Escallonia* are not certainly indicative of temperate conditions nor is *Euphorbia*, although the latter as well as *Porliera* indicate more or less aridity. It is not possible to determine what the relation of these few forms is to the predominantly humid and tropical character of the bulk of the Potosi flora. Possibly it is to be explained by local aridity of sandy areas of soil under a tropical sun, or there may have been elevations near to the basin of sedimentation that would explain this element of the fossil flora. The absence of large-leafed species in the flora as a whole and the vast predominance of compound leaves with small leaflets, may also have been due to a sandy substratum.

While botanists may justly object to the reference of some of the Potosi forms to one genus rather than another when several alternatives are presented, and this comment is especially applicable to the leaflets of the Leguminosae which are so abundant in the Potosi deposits, none, I think, can oppose the conclusion that whatever the opinion of students regarding the validity of some of the identifications, in no case does this uncertainty in any number of specific cases alter the outstanding result of this study, namely, that the fossil flora found in the tuffs at Potosi is very similar to existing assemblages found in eastern Bolivia or at various other places in the Amazon Basin, or that the conditions of existence for the fossil flora must have been similar to that under which those existing floras with which it has been compared are flourishing and quite different from the environmental conditions prevailing at the present time within the eastern Andes of Bolivia or on the high plateau or in fact anywhere west of the region of heavy rains on the eastern slopes of the front range.

From a consideration of all the evidence available it is concluded that the flora is Pliocene in age and that the major elevation of the eastern Andes of Bolivia and the high plateau took place in the late Pliocene and throughout the Pleistocene and that the extensive mineralization of this region also took place during this same period.

Fossil species.	Potosi.	NW. of Potosi.	Corocoro.	Most closely related existing species.	Range.
Polystichum bolivianum	×		×	*Polystichum triangulum* (Linnaeus) Fée.	West Indies.
Lomariopsis tertiaria	×			*Lomariopsis sorbifolia* (Linnaeus.)	Guatemala and Antilles to Brazil.
Lomariopsis, (?) sp	×				
Acrostichum lincarifolium	×			*Acrostichum lineare* Fée	Brazil.
Gymnogramme, (?) sp	×			*Gymnogramme trifoliata* Desveaux.	Peru and Brazil.
Pecopteris, sp	×				
Podocarpus fossilis	×			*Podocarpus lamberti* Klotz	Brazil.
Festuca, sp	×			*Festuca*, spp	Andean.
Poacites, sp	×				
Phragmites, sp	×				
Palmophyllum, sp		×			
Myrica banksioides	×			*Myrica microcarpa* Bentham	West Indies.
Myrica engelhardtii	×				
Myrica wendtii	×				
Myricophyllum, sp	×				
Ruprechtia braunii	×			*Ruprechtia laurifolia* Martius.	Brazil.
Carpolithus viornaformis	×			*Viorna*, spp	South America.
Capparis multincrvis	×			*Capparis jacobinae* Maricaud.	Brazil.
Escallonia wendtii	×			*Escallonia*, spp	Andean and elsewhere in South America.
Weinmannia brittoni	×			*Weinmannia glabra* De Candolle.	Southern Mexico, West Indies, and northern South America.
Weinmannia potosina	×				
Acacia uninervifolia	×		×	*Acacia peradora* De Candolle	Tropical South America.
Acacia dimidiato-cordata	×			*Acacia fasciculata* Kunth	Brazil.
Acacia tenuifolia	×			*Acacia pedicellata* Bentham	Eastern Bolivia and Brazil.
Inga ochseniusi	×			*Inga blanchetiana* Bentham	Brazil.
Pithecolobium brittonianum.	×			*Pithecolobium dulce* Bentham.	West Indies and northern South America.
Pithecolobium tertiarum	×			*Pithecolobium trapezifolium* Bentham.	Colombia, Guiana, and Brazil.
Mimosa arcuatifolia	×		×	*Mimosa invisa*, Martius and *Mimosa lupulina* Bentham	Southern Mexico and West Indies to Brazil. Brazil.
Mimosa montanoides	×			*Mimosa montana* Humboldt, Bonpland, Kunth.	Peru.
Mimosites engelhardti	×		×		
Calliandra obliqua	×			*Calliandra macrocephala* Bentham.	Brazil.
Calliandra ovatifolia	×			*Calliandra leptopoda* Bentham.	Do.
Enterolobium grandifolium.	×			*Enterolobium timbouva* Martius.	West Indies to Brazil and eastern Bolivia.
Enterolobium parvifolium	×			*Enterolobium schomburgkii* Bentham.	Panama to Brazil.
Cassia singewaldi	×				
Cassia rigidulifolia	×			*Cassia mucronata* Sprengel	Brazil.
Cassia obscura	×			*Cassia rotundifolia* Persoon	Mexico and West Indies to Brazil.
Cassia wendtii	×				
Cassia membranacea	×				
Cassia ligustrinaformis	×		×	*Cassia ligustrina* Linnaeus	Tropical South America.
Cassia cultrifoliaformis	×			*Cassia cultrifolia* Humboldt, Bonpland, Kunth.	Northern South America.
Cassia cristoides	×			*Cassia crista* Jacquin	Central America and West Indies to Brazil.
Cassia chrysocarpoides	×			*Cassia chrysocarpa* Desveaux	Guiana and Brazil.
Cassia franckei	×			*Cassia deutata* Vogel	Brazil.
Caesalpinia gmehlingi	×			*Caesalpinia pulcherrima* Swartz.	Mexico and West Indies to Brazil.
Caesalpinia sessilifoloides.	×			*Caesalpinia microphylla* De Candolle.	Brazil.
Caesalpinites potosianus	×				
Copaifera potosiana	×			*Copaifera trapezifolia* Hayne	Amazon Basin.
Copaifera corocoriana			×		
Bauhinia potosiana	×			*Bauhinia*, spp	Eastern Bolivia.
Peltophorum membranaceum.	×			*Peltophorum vogelianum* Bentham.	Brazil.
Amicia antigua	×			*Amicia Lobbiana* Bentham	Andean (Bolivia).
Machaerium eriocarpoides	×			*Machaerium eriocarpum* Bentham.	East Bolivia and Brazil.
Machaerium milleri	×				
Dalbergia potosiana	×				
Dalbergia chartacea	×			*Dalbergia variabilis* Vogel	Peru, Guiana and Brazil.
Dalbergia (?) *antigua*	×			*Dalbergia riparia* Bentham	Amazon Basin.
Desmodium ellipticum	×			*Desmodium barbatum* Bentham.	Southern Mexico and West Indies to Brazil.
Drepanocarpus franckei	×			*Drepanocarpus lunatus* Mayer.	Do.
Aeschynomene bolivianum	×			*Aeschynomene falcatum* De Candolle.	Mexico to Brazil.

Fossil species.	Potosi.	NW of Potosi.	Corocoro.	Most closely related existing species.	Range.
Sweetia tertiaria	×			*Sweetia elegans* Bentham	Brazil.
Lonchocarpus obtusifolius	×			*Lonchocarpus obtusus* Bentham.	Do.
Platypodium potosianum.	×			*Platypodium elegans* Vogel	Panama to Brazil and East Bolivia.
Leguminosites (?) *globularis.*	×				
Leguminosites, sp	×				
Porlieria tertiaria	×			*Porlieria*, spp	Andean and extra Andean arid.
Euphorbia, (?) sp	×			*Euphorbia*, spp	Arid South America.
Passiflora canfieldi	×			*Passiflora*, spp	Eastern Bolivia.
Myrteola potosiana	×			*Myrteola*, spp	Andean.
Terminalia antiqua	×			*Terminalia*, spp	Tropical South America.
Terminalia singewaldi			×	do	Do.
Cuphea antiqua	×			*Cuphea*, spp	Eastern Bolivia.
Gaylussacia tertiaria	×			*Gaylussacia tedifolia* Martius.	Brazil.
Apocynophyllum potosianum.	×				
Jacaranda potosina	×			*Jacaranda cuspidifolia* Martius.	Do.
Rubiacites nummulariaoides.	×				
Cypselites potosianus	×				
Carpolithus engelhardti	×				
Carpolithus, sp. nos. 1 to 5.	×				
Antholithus quinquepartitus.	×				
Spined stem	×				

SYSTEMATIC DESCRIPTIONS.

The following description of the new species of brachiopod is contributed by Prof. Charles Schuchert, of Yale University:

DISCINISCA SINGEWALDI, new species.

This common and very interesting inarticulate brachiopod is related to the lamellose and nonradially striate *Discinisca lamellosa* (Broderip)[1] which lives in less than 60 feet of water all along the South American coast from Chile to Panama. The new species is small for the genus and differs from all other forms in that there is a more or less distinct and flat false area beneath the elevated beak or umbo of the dorsal valve. The outline of the shells varies from circular to oval; the dorsal valve is moderately convex with the umbo marginal or nearly so, and the abundant lamellae all terminate in decidedly projecting bands; the ventral valve is more or less flat, less distinctly lamellose, and the pedicle cleft is open from the umbo, which is situated at about one-third the length of the shell, to the posterior margin.

A nearly circular shell measures 10 mm. long, 11 mm. wide, and 4 mm. high. An oval specimen measures 9 mm. long, 7 mm. wide, and 2.5 mm. high.

Locality and geologic age.—These shells were collected by Professors Singewald and Miller at Huakachi Hill, near Potosi, Bolivia, at an elevation of 13,500 feet above the level of the Pacific Ocean. In regard to the age of the strata yielding these brachiopods, it can be

[1] See Davidson, Trans. Linnean Soc. London, Zoology, vol. 4, 1888, pp. 197–200; and Blochmann, Untersuchungen über den Bau der Brachiopoden, Jena, 1900, pp. 69–70.

said that they appear to be of late Tertiary age and either of Miocene or Pliocene time. This conclusion is based on the close relation of *D. singewaldi* to *D. lamellosa*. Since Miocene time *Discinisca* has been abundant, and the striate-lamellose group is common in the Miocene of the Atlantic and eastern Gulf States (*D. lugubris*), and occurs rarely in the Coos Bay formation of the Pacific States (*D. oregonensis*). To-day this group of Discinisca is common all along

FIG. 2.—DISCINISCA SINGEWALDI SCHUCHERT.

the Pacific coast of South America (*D. laevis, D. cumingii, D. strigata*), and the lamellose section is also represented (*D. lamellosa*).

It is a great surprise to learn that these shells were collected at 13,500 feet above the sea, for this means that the Andes in the region of Bolivia have been raised that much since Miocene or even Pliocene time. No brachiopod has ever adapted itself to fresh waters, though Lingulas continue to live in the much freshened waters of the present sea margin. The evidence is clear that *D. singewaldi* is a marine animal, living in shallow waters whose depth probably did not exceed 60 feet. The exact age of the species and of the beds in which it occurs must be determined from other evidence, though they appear to be referable to either Miocene or Pliocene time.

Cotypes.—In the Peabody Museum of Yale University.

PTERIDOPHYTA.

Order FILICALES.

Family POLYPODIACEAE.

Genus POLYSTICHUM Roth.

POLYSTICHUM BOLIVIANUM, new species.

Plate 15, fig. 1.

Description.—Frond character unknown. Pinnules small, inequilaterally trilobate, short stalked. Length, 9 mm.; maximum width, 5.5 mm. Margin entire or with an occasional mucronate tooth, distinctly not spinulose. Texture coriaceous. The pinnule on one side above the middle shows an outwardly directed, conical, acuminate pointed lobe subtending an open rectangular sinus. On the other side one-third of the distance from the base is a similar conical acuminate lobe slightly larger than that of the opposite side, subtending a similar sinus. About halfway to the tip of the pinnule on this side there is a second vestigial lobe or mucronate tooth above which the margin curves inward to the conical acuminate tip of the

pinnule. The venation is largely immersed in the thick lamina. At the base three veins diverge at acute angles of about 20° on one side and 30° on the other, the lateral ones ending in the tips of the lateral lobes and the median one in the tip of the pinnule. A few subordinate dichotomously forking veinlets are faintly seen. On subordinate branches from these three primary veins on each side are impressions of round sori with a slightly raised center, about 0.25 mm. in diameter.

This fern is very obviously a species of *Polystichum*, the characters of which as a whole are very well known. When it comes to making comparisons with existing species of *Polystichum* difficulties are almost unsurmountable for several reasons—namely, the inadequate amount of fossil material, the variability of the recent species, the lack of sufficient comparative material, and the difficulty of connecting mere names of recent species with actual specimens.

Polystichum is a large genus in the existing flora found on all the continents, and hence with a cosmopolitan distribution. It contains many vague or but little understood species and many extremely variable and polymorphous forms. It is found in both the tropical and boreal regions (Greenland, Antarctica) and on many high mountains, and its present distribution is clearly indicative of a long geological history which is almost entirely unknown.

Maxon, in a recent revision [1] of the West Indian species, recognizes 19 species in that region. He has been good enough to examine the fossil for me and considers it an ally of the historic and extremely variable *Polystichum triangulum* (Linnaeus) Fée. The latter, as far as known, is now strictly West Indian in its distribution. In Jamaica it is common in rocky situations up to 1,800 meters. Other West Indian species whose pinnules are more or less closely similar to the fossil are the Cuban species *Polystichum decoratum* Maxon, *Polystichum heterolepis* Fée, and the Jamaican *Polystichum rhizophorum* (Jenman) Maxon.

There are a number of existing species in South America, some ranging from the Antilles into Brazil and others ranging from Central America into the Andean region, while still others are confined to South America. I have examined specimens of *Polystichum flexum* (Kuntz) Phillippi, from Juan Fernandez, *Polystichum capense* (Willdenow) J. Smith, from Chile and *Polystichum mohrioides* (Bory) Presl from the Falkland Islands. These, while they show the generic likeness of the fossil, are not specifically close to it. Of the three the last is most like the fossil, but it is more dissimilar than the West Indian species previously enumerated. Other existing South American species which I have not seen include *Polystichum dubium* (Hooker) Diels of the Andes of Ecuador and Peru, which is markedly different from the fossil in its pinnate and anastomosing veinlets

[1] Maxon, W. R., Contr. U. S. Natl. Herb., vol. 13, pt. 1, 1909, pp 25-39, pls 2-9.

Another variable form *Polystichum denticulatum* (Swartz) J. Smith of neotropical South America has reduced forms in the higher Andes, as, for example, the var *rigidissimum* described by Hooker from Colombia; but this type also seems to be remote from the fossil.

The resemblances between the fossil form and still existing West Indian species I regard as valid evidence of relationship, and while it is probable that the types mentioned from the latter region are represented in the rainforest along the eastern foothills of the present Andes, this resemblance is sufficient, it seems to me, to stamp the fossil as a form that dwelt as either an epiphyte or a rock dwelling form in a region less desiccated and warmer than that inhabited by such modern forms as *Polystichum mohrioides* (Bory) Presl of southern Chile and Patagonia, or *Polystichum denticulatum*, var *rigidissimum* Hooker of the high Andes of Colombia.

This species is represented by a pinnule and a sori bearing counterpart from Potosi and by the fragment of a pinnule from Corocoro.

Cotypes.—Cat. No. 35078 *a* and *b*, U.S.N.M.

Genus LOMARIOPSIS Fée.

LOMARIOPSIS TERTIARIA Engelhardt.

Lomariopsis tertiaria ENGELHARDT, Sitz. Naturw. Gesell. Isis in Dresden, 1894, Abh. 1, p. 4, pl. 1, fig. 3.

Description.—This species was described from Potosi by Engelhardt, who compared it with the existing *Lomariopsis sorbifolia* Linnaeus which ranges from Guatemala and the Antilles to Brazil. It has not been recognized in the collections studied by me.

Lomariopsis is a characteristic type of the tropical forests of both hemispheres, with relatively few but highly polymorphic existing species.

LOMARIOPSIS, (?) species, Engelhardt.

Lomariopsis, (?) species, ENGELHARDT, Sitz. Naturw. Gesell. Isis in Dresden, 1894, Abh. 1, p. 4, pl. 1, fig. 2.

Description.—A fragment of a larger form, apparently based on the single specimen figured, was described from Potosi by Engelhardt. It has not been recognized in the other collections, and while the generic reference is probably correct the material is much too restricted for definite characterization.

Genus ACROSTICHUM Linnaeus.

ACROSTICHUM LINEARIFOLIUM Engelhardt.

Acrostichum linearifolium ENGELHARDT, Sitz. Naturw. Gesell. Isis in Dresden, 1894, Abh. 1, p. 4, pl. 1, fig. 4.

Description.—This species, which was based on an inadequate amount of material, has been briefly described by Englehardt, who compared it with the existing *Acrostichum lineare* Fée of Brazil.

Without seeing the original material it is impossible to arrive at a conclusion regarding its validity. There are some small fragments in the present collection that appear to have the venation of *Acrostichum* and these may represent this species.

Genus GYMNOGRAMME Desveaux.

GYMNOGRAMME, (?) species, Engelhardt.

Gymnogramme, (?) species, ENGELHARDT, Sitz. Naturw. Gesell. Isis in Dresden, 1894, Abh. 1, p. 4, pl. 1, fig. 1.

Description.—This somewhat questionably identified form was described from Potosi by Engelhardt and has not been recognized in the more recent collections. It was compared with the existing *Gymnogramme trifoliata* Desveaux, a tropical species of Peru and Brazil. *Gymnogramme* has numerous existing species in South America, to which region it is practically confined, and it is well represented in the drier regions of the higher Andes from Colombia to Bolivia.

Genus PECOPTERIS Brongniart.

PECOPTERIS, species, Engelhardt.

Pecopteris, species, ENGELHARDT, Sitz. Naturw. Gesell. Isis in Dresden, 1894, Abh. 1, p. 5, pl. 1, fig. 15.

Description.—A small undeterminable fragment of a fern is described and figured from Potosi by Englehardt under the above noncommital name, more properly restricted to Paleozoic fern-like forms. Its botanical affinity is not determinable.

CONIFEROPHYTA.

Order TAXALES.

Family TAXACEAE.

Subfamily PODOCARPEAE.

Genus PODOCARPUS L'Heritier.

PODOCARPUS FOSSILIS Engelhardt.

Plate 15, fig. 2.

Podocarpus fossilis ENGELHARDT, Sitz. Naturw. Gesell. Isis in Dresden, 1894, Abh. 1, p. 5, pl. 1, fig. 12.

Description.—Leaves sessile, linear-lanceolate and falcate in outline, acutely pointed at both ends. Margins entire. Texture very coriaceous. Length, about 4 cm.; maximum width, in the middle part of the leaf, about 3 mm. Midrib stout, impressed on the upper surface. Secondaries longitudinally parallel, 5 or 6 equally spaced in each half of the lamina.

This characteristic species is represented by fragments in the present collection, but a complete leaf is reproduced from Engelhardt's figure. It is clearly referable to *Podocarpus*, belonging to the section *Eupodocarpus* of Endlicher, and is comparable with the existing *Podocarpus lamberti* Klotzsch of middle and southern Brazil.

The existing species of *Podocarpus* number over 40 species and they are as dominant representatives of the Coniferales in the Southern Hemisphere as are the pines in the northern. They extend northward to China and Japan through the East Indian region and to Jamaica and Central America in the Western Hemisphere, and have representatives in all three of the great southern land masses, as well as in Madagascar and New Zealand. This distribution is suggestive of a long geological history in keeping with which certain forms from the British Jurassic and Lower Cretaceous and the American Lower Cretaceous are referred to the genus *Nageiopsis*, and considered as the prototypes of the *Nageia* section of *Podocarpus*, which should probably be raised to its former position of generic rank. Some 15 or more fossil species of *Podocarpus* have been described chiefly from the European Tertiary, and no conclusively identified fossil forms, other than the present species, have been discovered on the American continents. The section *Eupodocarpus* (Endlicher) to which the present fossil species belongs comprises over 30 existing species, almost as widely distributed as the genus, with several West Indian and South American species, but found also in Africa, Asia, Australia, and New Zealand. All of these are much alike and the fossil might be successfully compared with almost any one of them. *Podocarpus* is not found at the present time west of the front range of the Andes, but is represented by two or more species in the forests of the eastern slopes, the so-called Ceja region of Herzog.[1] In northern Peru it is also found in the lateral valleys inside the front range, the most widespread form being *Podocarpus oleifolius*, a shrubby or arborescent form, which in latitude 6° reaches altitudes up to 3,300 meters on the eastern slopes of the central Cordillera.

ANGIOSPERMOPHYTA.

Class MONOCOTYLEDONAE.

Order POALES.

Family POACEAE.

Genus FESTUCA Linnaeus.

FESTUCA, species.

Plate 15, figs. 3, 4.

Description.—Flowering scales rounded on the back, about 7 mm. long, longitudinally veined, awned. The latter about as long or twice as long as the scale.

[1] Herzog, Th., Pflanzenformationen Ost Bolivias, 1910.

These remains are clearly those of a grass. Several specimens of different sizes are present, one slightly smaller and with two awns. They are too incomplete for accurate characterization and are supposed to represent a fossil species of *Festuca*, although they may represent the allied genus *Bromus* Linnaeus.

The existing species of *Festuca* are mostly tufted perennials and comprise upwards of 100 species, found on all the continents in temperate situations and represented by tall species in the Ecuador Andes. *Bromus* has about half as many existing species, is nearly as widely distributed, but more prevailingly in the Northern Hemisphere, although present in South America. It is temperate in habitat, although sparingly present in montane equatorial regions.

Cat. No. 35079, U.S.N.M.

Genus POACITES Brongniart.

POACITES, species, Engelhardt.

Poacites, species, ENGELHARDT, Sitz. Naturw. Gesell. Isis in Dresden, 1894, Abh. 1, p. 5, pl. 1, fig. 5.

Description.—Fragments of the leaves of grasses are occasional in the Potosi deposits. Engelhardt records and figures one under the above name. They are not botanically determinable and are of interest merely in indicating the presence of grasses in the Potosi flora already more definitely indicated by the forms which I have referred to *Festuca*.

Genus PHRAGMITES Trinius.

PHRAGMITES, species.

Plate 15, fig. 5.

Description.—A fragment of a finely striated stem with short internodes indicates the presence of a rather large grass in the Potosi flora. It is referred to *Phragmites* as a form genus for fossil grasses of unknown generic affinity, and the remains are entirely too incomplete to be characterized.

Cat. No. 35080, U.S.N.M.

Order ARECALES.

Family ARECACEAE.

Genus PALMOPHYLLUM Brongniart.

PALMOPHYLLUM, species.

Description.—A small fragment of the basal part of a leaf of a small fan palm was collected from shales near La Palca mill about 12 kilometers northwest of Potosi.

It is too incomplete for generic identification, and its stratigraphic position with relation to the Potosi tuffs is also unknown.

Class DICOTYLEDONAE.

Order MYRICALES.

Family MYRICACEAE.

Genus MYRICA Linnaeus.

MYRICA BANKSIOIDES Engelhardt.

Plate 15, figs. 6, 7.

Myrica banksioides ENGELHARDT, Sitz. Naturw. Gesell. Isis in Dresden, 1887, Abh. 5, p. 36, pl. 1, figs. 10, 14; 1894, Abh. 1, p. 5, pl. 1, figs. 6, 7, 14, 17.—BRITTON, Trans. Amer. Inst. Min. Eng., vol. 21, 1893, p. 256, figs. 5–8.

Description.—Leaves linear lanceolate in outline, frequently falcate, gradually narrowed to the acuminate tip and to the narrowly cuneate base. Length ranging from 3 cm. to 8 cm. Maximum width, in the middle part of the leaf, ranging from 4 mm. to 9 mm. Margins sometimes nearly entire, usually toothed; the basal one-third is usually entire, above which irregularly developed and more or less distant serrate teeth are present. The teeth may be small and straight-serrate or large and salient-serrate, separated by regularly curved sinuses, or small and directed upward, thus approaching aquiline-serrate. The smaller specimen figured in the present report or Engelhardt's figure 14 (1894) illustrate the unequal character and maximum size of the teeth. The teeth of the opposite margins may show differences in character as illustrated in my smaller figure cited above. The texture is coriaceous. In the very abundant material no petioles are preserved. The midrib is stout and prominent on the lower surface of the leaf. The secondaries are numerous, subparallel, thick, and more or less immersed in the leaf substance; they diverge from the midrib at angles of about 45° and are generally rather straight in their courses. Each marginal tooth is traversed by a craspedodrome secondary. Where marginal teeth are not developed the secondaries are camptodrome, and there are usually one or more camptodrome secondaries between adjacent craspedodrome secondaries. The tertiary venation is obscure and largely immersed.

This unmistakable species of *Myrica* is the most abundant fossil in the present collections, except for the minute leaflets of *Calliandra obliqua* Engelhardt, and it appears to have been equally abundant in the collections studied by both Engelhardt and Britton. Engelhardt [1] compared it with *Myrica banksiaefolia* Unger,[2] of the Oligocene and Miocene of Europe, and with *Myrica polymorpha* Schimper,[3] of the Oligocene of Europe, and said to be present in the upper Eocene of

[1] Sitz Naturw. Gesell, Isis in Dresden, 1887, Abh. 5, p. 36.
[2] Unger, Foss. Fl. v. Sotzka, 1850, p. 160, pl. 27, figs. 3, 4.
[3] Schimper, Pal. Végét., vol. 2, 1872, p. 536.

Wyoming. Such comparisons are not worth much, however, since there are a large number of described fossil species from a variety of horizons that are very similar to the present species. Among recent species it is said to much resemble *Myrica microcarpa* Bentham of Jamaica. I have been unable to see specimens of *Myrica variibractea* De Candolle and *Myrica weberbaueri* De Candolle, which occur in the existing flora of the interandean region of central Peru.

Plesiotypes.—Cat. Nos. 35081, c5082, U.S.N.M.

MYRICA ENGELHARDTII Britton.

Myrica engelhardtii BRITTON, Trans. Amer. Inst. Min. Eng., vol. 21, 1893, p. 258, fig. 19.

Description.—Leaves of small size, sessile, obtusely pointed at the apex, narrowly cuneate at the base. Margins with remote, small serrate teeth. Length, about 2.5 cm.; maximum width, about 6 mm. Midrib stout, slightly curved. Secondaries thin, numerous, regularly spaced, straight, subparallel, craspedodrome; about 17 pairs diverge from the midrib at wide angles and terminate in the marginal teeth.

This species was described from Potosi by Britton and was based upon the single specimen figured. It is not contained in the collections studied by me.

In view of its rarity and small size and in consideration of the variability of the very abundant *Myrica banksioides* Engelhardt, it seems probable that *Myrica engelhardtii* is simply a small leafed variant of that species.

MYRICA WENDTII Britton.

Myrica wendtii BRITTON, Trans. Amer. Inst. Min. Eng., vol. 21, 1893, p. 258, figs. 1–4, 20.

Description.—Leaves relatively large, lanceolate or oblong lanceolate in outline and frequently falcate. Apex narrowly pointed, almost invariably broken away. Base narrowly cuneate. Margins entire at the base; throughout the greater part of their length coarsely and irregularly serrate, the teeth varying from aquiline to salient or straight serrate. Midrib stout, prominent no the lower surface of the leaf. Texture coriaceous. Length, 6 cm. to 10 cm.; maximum width, in the middle part of the leaf, 1 cm. to 2 cm. Secondaries thin, numerous, subparallel, craspedodrome, diverging from the midrib at wide angles, nearly straight in their outward course, terminating in the marginal teeth.

This species was apparently abundant in the collections studied by Britton, but is sparingly represented by fragmentary material in the collections studied by me. It is possible that it may merely represent unusually large forms of the common and variable *Myrica banksioides* Engelhardt.

Genus MYRICOPHYLLUM Saporta.

MYRICOPHYLLUM, species, Engelhardt.

Myricophyllum, species, ENGELHARDT, Sitz. Naturw. Gesell. Isis in Dresden, 1894, Abh. 1, p. 6, pl. 1, fig. 24.

Description.—Incomplete material of a linear leaf, with a stout midrib, prominently toothed margin, and stout secondaries diverging from the midrib at wide angles, every second or third one ending in a marginal tooth; the balance camptodrome.

The only known specimen is the small fragment figured by Engelhardt. It is clearly distinct from the other members of the Potosi flora, and apparently represents a striking Comptonia-like *Myrica*.

Order POLYGONALES.

Family POLYGONACEAE.

Genus RUPRECHTIA C. A. Meyer.

RUPRECHTIA BRAUNII Engelhardt.

Plate 15, fig. 8.

Ruprechtia braunii ENGELHARDT, Sitz. Naturw. Gesell. Isis in Dresden, 1894, Abh. 1, p. 6, pl. 1, fig. 19.

Description.—Leaves linear lanceolate in outline. Apex gradually narrowed, acuminate. Base acuminate, inequilateral. Margins entire, more or less undulate. Texture coriaceous. Length, about 6.25 cm. Maximum width, at or below the middle, about 9 mm. Petiole not preserved. Midrib thin but prominent on the lower surface of the leaf, inclined to be flexuous. Secondaries numerous, thin but prominent, ascending, somewhat irregularly spaced; they diverge from the midrib at angles of about 40° and are camptodrome.

The present species may be compared with the leaves of the existing *Triplaris salicifolia* from southern Brazil which C. A. Meyer refers to *Ruprechtia* and with *Ruprechtia laurifolia* Martius of eastern Brazil. *Ruprechtia* is a genus, not otherwise known in the fossil state, with about 20 existing species of shrubs and trees of tropical and subtropical regions of South America.

Plesiotypes.—Cat. No. 35125, U.S.N.M.

Order RANALES.

Family RANUNCULACEAE.

Genus CARPOLITHUS Allioni.

CARPOLITHUS VIORNAFORMIS, new species.

Plate 15, fig. 9.

Description.—A fruit referable of the Ranunculaceae and apparently representing a one-seeded ovate achene with a long slender curved naked style. Achene about 1 mm. long, rounded at the base and pointed distad. Style about 7 mm. long.

This well-marked form is very suggestive of certain existing species commonly referred to the genus *Clematis*, especially some of the subtropical species sometimes referred to the genus *Viorna* Reichenbach. As there are other genera in this family with similar fruits and the material is not available for extended comparisons with recent South American forms, it is referred to the form genus *Carpolithus*.

Holotype.—Cat. No. 35083, U.S.N.M.

Order PAPAVERALES.

Family CAPPARIDACEAE.

Genus CAPPARIS Linnaeus.

CAPPARIS MULTINERVIS Engelhardt.

Plate 15, fig. 10.

Capparis multinervis ENGELHARDT, Sitz. Naturw. Gesell. Isis in Dresden, 1894, Abh. 1, p. 7, pl. 1, fig. 18.

Description.—Leaves short petioled, linear, with an obtusely rounded tip and a cuneate base. Margins entire. Texture coriaceous. Length 6 or 7 cm. Maximum width, midway between the apex and the base, 7 to 12 mm. Petiole stout, curved, about 3 or 4 mm. in length. Midrib stout, straight except basally, where it is curved, prominent on the lower surface of the leaf. Secondaries numerous, widely but regularly spaced, stout and somewhat prominent; 15 to 18 opposite to alternate pairs diverge from the midrib at wide angles, sometimes as great as 75° in the median part of the leaf, but averaging somewhat less generally; they are nearly straight and subparallel in their outward course for three-fourths of the distance to the margin, where they curve upward in a broad camptodrome arch to join the secondary next above. The tertiaries are mostly obsolete, occasionally they are seen but not sufficiently to determine the areolation.

A single specimen, somewhat larger than that figured by Engelhardt, is contained in the present collection. *Capparis*, although with usually well-marked characters of both form and venation, has a practically unknown geological history. An unquestionable species from the lower Eocene of the southern United States[1] is very similar to the present species. A second and somewhat doubtfully determined form was recorded by Unger from the European Miocene. The genus comprises about 100 existing species of shrubs and small trees of the equatorial region and, although present in the Eastern Hemisphere, the bulk of the forms occur in the American Tropics, especially in Central and South America. The Potosi species is

[1] Berry, E. W., Lower Eocene Floras of southeastern North America. U. S. Geol. Surv. Prof. Paper 91, 1916, p. 218, pl. 44, figs. 1-3; pl. 52, fig. 5.

very similar to a number of existing forms, among which may be mentioned *Capparis domingenesis* Strengel and *Capparis longifolia* of the West Indies, *Capparis augustfolia* Humboldt, Bonpland, and Kunth of Central America and *Capparis jacobinae* Moricaud of Brazil. In the existing flora of Bolivia there are several species of Capparis, in the Thornbush or Gran Chaco country of eastern Bolivia, and other species occur in the Andean outliers of Santa Cruz and Cochabamba.

Plesiotype.—Cat. No. 35084 N.S.N.M.

Order ROSALES.

Family SAXIFRAGACEAE.

Genus ESCALLONIA Linnaeus.

ESCALLONIA WENDTII Britton.

Plate 15, fig. 11.

Escallonia wendtii BRITTON, Trans. Amer. Inst. Mining Eng., vol. 21, 1893, p. 254, figs. 14, 15.

Description.—Leaves of medium size, ovate or elliptical in outline with a bluntly pointed apex and a broadly cuneate base. Margins crenulate above, the teeth becoming gradually more widely spaced below the middle and passing by an insensible transition into small widely spaced serrate teeth, which eventually become obsolete, the lower one-third of the margins being entire. Length 4 to 4.5 cm. Maximum width, midway between the apex and the base, 2.25 to 2.5 cm. Petiole missing or absent. Midrib stout and prominent, slightly curved. Secondaries thin, about nine pairs diverge from the midrib at angles of about 45°, somewhat unequally spaced, subparallel and camptodrome. Tertiaries not made out.

This species was described by Britton from the two specimens figured by him and is not contained in the collections from Potosi studied by me.

Escallonia contains about 50 existing species of shrubs or small trees, confined to and widespread in South America, with many Andean species.

If correctly identified it is one of the few fossil forms found at Potosi that would not be out of place in a dry montane environment, but as other of the numerous existing species are found in somewhat different environments east of the present mountains, its significance is equivocal.

Family CUNONIACEAE.

Genus WEINMANNIA Linnaeus.

WEINMANNIA BRITTONI Engelhardt.

Plate 15, fig. 12.

Weinmannia brittoni ENGLEHARDT, Sitz. Naturw. Gesell. Isis in Dresden, 1894, Abh. 1, p. 6, pl. 1, fig. 16.

Description.—Leaflets small, sessile, ovate or obovate in general outline, with a narrowed acuminate base and a broadly rounded apex. Margins with a few relatively large serrate teeth in the upper part, entire toward the base. Texture coriaceous. Length, about 1 cm. Maximum width, in the middle part of the leaflet, about 5.5 mm. Midrib stout, slightly curved. Secondaries thin, few in number, subparallel, diverging from the midrib at angles of about 45°, craspedodrome.

This small species was described from Potosi by Engelhardt and is apparently unrepresented in the other collections. It was compared with the existing *Adesmia muricata* De Candolle (Leguminosae), but more particularly with *Weinmannia glabra* De Candolle, a species found from the West Indies and southern Mexico throughout northern South America (Colombia, Venezuela, Guiana.)

The genus *Weinmannia* contains about 75 existing species of shrubs or trees, of which over half are confined to temperate and tropical South America and not uncommon in the warmer parts of the Andean region. The remaining species are found in Madagascar, Australia, New Zealand, and Oceanica. Upwards of a score of fossil species have been described, mostly from Europe and North America, and well-preserved and undoubted forms are present in the Miocene lake deposits at Florissant, Colorado.

WEINMANNIA POTOSINA (Britton).

Plate 15, fig. 13.

Myrica potosina BRITTON, Trans. Amer. Inst. Min. Eng., vol. 21, 1893, p. 258, figs. 9, 10.

Description.—Leaflets sessile, lanceolate in outline, with an acute apex and a more or less inequilateral rounded to cuneate base. Margins finely serrate, entire at the base. Texture subcoriaceous. Length ranging from 1.5 to 2.25 cm. Maximum width, midway between the apex and the base, ranging from 5 to 7 mm. Midrib stout, prominent, more or less curved. Secondaries thin but prominent, numerous, regularly spaced, subparallel, craspedodrome.

This species, at first regarded as a *Lomatia*, was described from Potosi by Britton as a new species of *Myrica*. It was apparently unrepresented in the collections studies by Engelhardt, but is represented by two specimens in the collections studied by me. I can not

see in these forms any relation to *Myrica* and regard them as representing a species of *Weinmannia*, thus making two species of this genus in the Potosi flora. It is well marked specifically from the other species of *Weinmannia*, which is a smaller, more coarsely toothed leaflet with a narrow base and rounded apex.

Plesiotypes.—Cat. No. 35126, U.S.N.M.

Family MIMOSACEAE.

Genus ACACIA Willdenow.

ACACIA UNINERVIFOLIA Engelhardt.

Plate 15, figs. 14, 15.

Acacia uninervifolia ENGELHARDT, Sitz. Naturw. Gesell. Isis in Dresden, 1894, Abh. 1, p. 11, pl. 1, figs. 10, 11, 20.

Description.—Leaflets or phyllodes sessile, somewhat variable in size, slightly or not at all inequilateral, lanceolate to linear lanceolate in outline, with an equally acuminate apex and base. Margins entire Texture coriaceous. Length, ranging from 1 to 2.25 cm. Maximum width, in the middle of the leaflet, ranging from 1 to 3.5 mm. Midrib relatively stout and prominent on the lower surface of the leaflets. Secondaries thin, numerous, regularly spaced and subparallel; about 15 pairs diverge from the midrib at angles of about 45°, curving regularly upward and ultimately camptodrome. Tertiary venation obsolete by immersion.

This species is common at Potosi and also occurs sparingly at Corocoro. It was described by Engelhardt[1] in 1894, who compared it with the phyllodes of the existing *Acacia paradoxa* De Candolle. Engelhardt's figure 20 shows a relatively shorter and wider form and may represent a leaflet of *Machaerium eriocarpoides* Engelhardt.

The present species is similar to *Mimosites Engelhardti* Berry, *Machaerium eriocarpoides* Engelhardt, and *Enterolobium grandifolium* Engelhardt. It is relatively longer and narrower than any of these and may be readily distinguished by the accompanying illustrations showing its extremes of size.

Plesiotypes.—Cat. No. 35085, 35086, U.S.N.M.

ACACIA DIMIDIATO-CORDATA Engelhardt.

Plate 15, figs. 16, 17, 18.

Acacia dimidiato-cordata ENGELHARDT, Sitz. Naturw. Gesell. Isis in Dresden, 1894, Abh. 1, p. 11, pl. 1, fig. 51.

Description.—Leaves even pinnate, leaflets small, sessile, elliptica in outline, with a rounded apex and an inequilateral base. Margins full and rounded, entire. Texture subcoriaceous. Length ranging from 2 to 8 mm. Maximum width ranging from 1 to 4 mm. Midrib

[1] Sitz. Naturf. Gesell. Isis in Dresden, 1894, Abh. 1, p. 11.

thin, scarcely distinguisable from a secondary which diverges from it at an acute angle at the base and sweeps upward nearly to the tip where it becomes lost in the tertiary areolation made up of acute proximal forks and distal camptodrome arches.

This peculiar species is abundant at Potosi and it appears to be identical with the single leaflet imperfectly figured by Engelhardt. In one case a pair of terminal leaflets are preserved in attachment, showing that the leaves were even pinnate. The majority of the leaflets approach the maximum of size and often fail to show the characteristic venation, which I assume was the case in the leaflet figured by Engelhardt. This venation is characteristic of certain modern species of *Acacia* and *Calliandra* and resembles modern species like *Acacia Roemeriana*, *Acacia fasciculata* Kunth [1] of Brazil or *Acacia crassifolia* A. Gray of Mexico.

Plesiotype.—Cat. No. 35087 to 35089, U.S.N.M.

ACACIA TENUIFOLIA Engelhardt.

Acacia tenuifolia ENGELHARDT, Sitz, Naturw. Gesell. Isis in Dresden, 1894, Abh. 1 p. 11, pl. 1, figs. 45, 46.

Description.—Leaflets small, sessile, oblong lanceolate, nearly equilateral, equally acutely pointed at both ends. Margins entire. Length, 1 to 1.25 cm. Maximum width, in the middle part of the leaflet, 4 to 5 mm. Midrib thin, straight. Secondaries about five thin camptodrome pairs.

This species is only doubtfully represented in the present collections. It is compared by Engelhardt with the existing *Acacia pedicellata* Bentham of eastern Bolivia and Brazil.

Genus INGA Willdenow.

INGA OCHSENIUSI Engelhardt.

Plate 15, fig. 19.

Inga ochseniusi ENGELHARDT, Sitz. Naturw. Gesell. Isis in Dresden, 1894, Abh. 1, p. 11, pl. 1, figs. 39, 40.

Description.—Leaflets small, sessile, inequilateral, elliptical in outline, nearly equally rounded at both ends, but the base much more inequilateral than the apex. Margins entire. Texture coriaceous. Length, about 11 mm. Maximum width, about 5 mm. Midrib stout, curved. Secondaries thin, numerous, camptodrome; those on the narrower side of the leaflet more ascending and forming a more acute angle with the midrib than those on the broader side.

This species was described by Engelhardt and has not been recognized in the other collections from Potosi. It was compared with the existing *Pithecolobium diversifolium* Bentham, *Inga flabelliformis*

[1] This species is usually known as *Mimosa fasciculata* Bentham having transferred it to the genus *Mimosa*.

Martius, and *Inga balnchetiana* Bentham, and is closest to the last, a Brazilian species.

The genus *Inga* contains a considerable number of fossil species and is found as early as the Upper Cretaceous in North America. There are several well-marked forms in the lower Eocene of the Mi-s sissippi embayment region. The existing species, upward of 200 in number, are confined to the American Tropics and reach their maximum of abundance and variation in the Brazilian region where about 66 species are already known. Tropical Peru ranks next in number of species with about 30. All of the five sections of the genus are represented in the existing flora of Bolivia with a total of 12 known species, all of which, so far as I know, being confined to eastern Bolivia.

Genus PITHECOLOBIUM Martius.

PITHECOLOBIUM BRITTONIANUM, new species.

Plate 15, fig. 20.

Cassia chrysocarpoides BRITTON, Trans. Amer. Inst. Min. Eng., 1893, fig. 36 (not figs. 29–35, 37).

Description.—Leaflets sessile, inequilateral, elliptical in general outline, with an emarginate tip and an inequilateral base which is straight on one side and full and rounded on the other. Length about 1.6 cm. Maximum width, about midway between the apex and the base, about 11.5 mm. Margins entire, full. Texture coriaceous. Midrib stout, curved, prominent on the lower surface of the leaflet. Secondaries numerous, subparrallel, comptodrome. Tertiaries obsolete.

This species is based on leaflets collected by Wendt and questionably referred by Britton to *Cassia chrysocarpoides* of Engelhardt[1] to which they are not related. It is the second species of *Pithecolobium* to be recorded from Potosi and is based upon more complete material than *Pithecolobium tertiarium* Engelhardt.[2] The fossil forms that have been referred to this genus are few in number, and include, in addition to the species already cited, two well-marked species from the lower Eocene and one from the lower Oligocene of the Mississippi embayment and a fourth species from the Tertiary of Colombia. The present Potosi species is very similar to *Pithecolobium oligocaenum* Berry[3] from the lower Oligocene of Louisiana.

The genus comprises considerably over 100 existing species, many of which are large trees and found in all tropical countries. Three-fourths of the species are confined to America, where they range from the West Indies and Central America to southern Brazil. Among

[1] Engelhardt, H., Sitz. Naturf. Gesell. Isis in Dresden, 1887, Abh. 4, p. 37, fig. 15.
[2] Idem., 1891, Abh. 1, p. 12.
[3] Berry, E. W., U. S. Geol. Survey Prof. Paper 98M, 1916 p. 239, pl. 55, fig. 10

the forms that I have seen *Pithecolobium dulce* Bentham of the West Indies and northern South America, may be mentioned as a closely similar form to *Pithecolobium brittonianum*. In Bolivia the genus is, so far as I know, found only east of the Andes in eastern Bolivia, where the flora is essentially similar to that of the Amazon basin. *P. scalare*, *P. saman*, and *P. sophoricarpum* are found along the banks of the Rio Piral, Rio Yapacani, and Rio Grande; *P. scalare* and *P. sophoricarpum* occur in the broken growth on the savannas of Santa Cruz and the last named is a member of the subandean woods that clothe the eastern slopes of the "Cordillera Real."

Holotype.—Cat. No. 35140, U.S.N.M.

PITHECOLOBIUM TERTIARIUM Engelhardt.

Pithecolobium tertiarium ENGELHARDT, Sitz. Naturw. Gesell. Isis in Dresden, 1894, Abh. 1, p. 12, pl. 1, fig. 33.

Description.—Leaflets rhombic with truncated inequilateral apex and an unknown base. Margins entire. Texture coriaceous. Somewhat larger than *Pithecolobium brittonianum* Berry and with a characteristic *Pithecolobium* venation.

This species was based upon a single fragmentary specimen and is not contained in the present collections, and thus may be regarded as of rare occurrence in the Pliocene flora of Potosi. It was compared by its describer with the existing *Pithecolobium trapezifolium* Bentham of Colombia, Guiana, and Brazil.

Genus MIMOSA Linnaeus.

MIMOSA ARCUATIFOLIA Engelhardt.

Plate 15, fig. 21.

Mimosa arcuatifolia ENGELHARDT, Sitz. Naturw. Gesell. Isis in Dresden, 1894, Abh. 1, p. 10, pl. 1, figs. 52–54.

Description.—Leaflets small, sessile, linear-lanceolate, arcuate, inequilateral, with a bluntly pointed apex and base, the latter slightly wider than the apex. Margins entire. Texture subcoriaceous. Length, 3 to 4 mm. Maximum width, in the middle part of the leaflet, about 1 mm. Venation obsolete except for the thin arcuate midrib.

This species is fairly abundant at Potosi and occurs also at Corocoro. It is distinguished with difficulty from the smaller leaflets of the more abundant *Calliandra obliqua*, with which Engelhardt in all probability confused it. The present species is, however, less linear, somewhat more slender and arcuate, with a less oblique base, and lacks the three primaries of *Calliandra obliqua*. According to Engelhardt it is very similar to the existing *Mimosa invisa* Martius, which ranges from southern Mexico and the West Indies to Brazil, or *Mimosa lupulina* Bentham of the last region. It may also be compared with

Mimosa microcephala Bonpland and with *Mimosa pectinata* Kunth. It has also less aptly been compared with the existing *Parkinsonia aculeata* Linnaeus.

Plesiotype.—Cat. No. 35090, U.S.N.M.

MIMOSA MONTANOIDES Engelhardt.

Mimosa montanoides ENGELHARDT, Sitz. Naturw. Gesell. Isis in Dresden, 1894, Abh. 1, p. 10, pl. 1, fig. 64.

Description.—Leaves small, even pinnate. Leaflets tiny, obovate, entire, 2 to 3 mm. in length by 0.5 to 1.5 mm. in maximum width, sessile.

This somewhat rare form was described by Engelhardt and is apparently absent in the other collections from Potosi. It is of somewhat doubtful botanical affinity, but is compared by its describer with the existing Peruvian species, *Mimosa montana* Humboldt, Bonpland, and Kunta.

Genus MIMOSITES Bowerbank.

MIMOSITES ENGELHARDTI, new name.

Plate 15, fig. 22.

Mimosites linearis ENGELHARDT, Sitz. Naturw. Gesell. Isis in Dresden, 1894, Abh. 1, p. 13, pl. 1, figs. 21, 35 (not *M. linearifolius* Lesquereux, 1878= *M. linearis* Knowlton, 1898).

Description.—Leaflets sessile, linear-lanceolate, slightly inequilateral, with an acuminate-cuspidate tip and an acuminate base. Margins entire. Texture coriaceous. Length, 12 to 15 mm. Maximum width, 2 to 3 mm. Midrib relatively stout. Secondaries obsolete by immersion.

The name of this species appears to be preoccupied by the *Mimosites linearifolius* of Lesquereux [1] from the Green River Eocene of Wyoming which Knowlton [2] amended to *Mimosites linearis* in 1898. While Engelhardt named his form in 1894, it seems desirable to rename it in order to avoid confusion, and I therefore take the liberty of calling it *engelhardti* as a slight token of esteem for the labors of M. Engelhardt.

This species is abundant at Potosi, always in the form of detached leaflets, and it occurs sparingly at Corocoro. It is very similar and liable to be confused with other leguminous leaflets found at Potosi—namely, *Acacia uninervifolia* Engelhardt, *Machaerium eriocarpoides* Engelhardt, and *Enterolobium grandifolium* Engelhardt. The first is more narrowly elongate and lanceolate, with more prominent camptodrome secondaries. The second is relatively shorter and wider, petiolulate, more lanceolate, and with more prominent secondaries. The third is larger, more inequilateral and more lanceolate.

Plesiotypes.—Cat. No. 35091, U.S.N.M.

[1] Lesquereux, L., Tertiary Flora, 1878, p. 300, pl. 59, fig. 7.
[2] Knowlton, F. H., Bull. 152 U. S. Geol. Survey, 1898, p. 144.

Genus CALLIANDRA Bentham.

CALLIANDRA OBLIQUA Engelhardt.

Plate 15, figs. 23–29.

Calliandra oblique ENGELHARDT, Sitz. Naturw. Gesell. Isis in Dresden, 1894, Abh. 1, p. 15, pl. 1, fig. 55.

Description.—Leaflets small, variable in size, oblong in outline, sessile or subsessile, acutely pointed, with a very inequilateral, obliquely truncate, or subcordate base. Margins entire. Texture coriaceous. Length ranging from 7 to 28 mm.; width ranging from 2 to 8 mm. Venation consisting of usually three primaries diverging from the base, sometimes with subordinate veins from the base, connected by circles toward the tip and connected by cross veinlets. A fragment of a leaf shows three pairs of opposite leaflets.

The leaflets of this species are the most abundant forms found at Potosi, and each parting of the tuffs is strewn with them. They are variable in size, and unless the venation can be seen are indistinguishable from the leaflets of *Mimosa arcuatifolia* Engelhardt; in fact, Engelhardt figured but a single leaflet of *Calliandra obliqua*, which is near its maximum size, and he probably confused the smaller leaflets with *Mimosa arcuatifolia*.

The venation is typical of *Calliandra*, but is also shared by some species of *Acacia*. The present species is said by Engelhardt to be practically identical with the existing *Calliandra macrocephala* Bentham, of Brazil. It is also identical with an unnamed *Calliandra* figured by Schenk.[1] It may also be compared with the existing *Calliandra parviflora* Bentham.

The modern species of *Calliandra* comprise over a hundred shrubs and small trees of tropical and subtropical America, with a few outlying species in farther India, Ceylon, and Madagascar. The genus is well represented in eastern Bolivia, and some species extend westward to the subandean zone of the eastern slopes, but so far as I know none occur in or west of the *Cordillera Real* or eastern Andes.

Plesiotypes.—Cat. No. 35128–35134, U.S.N.M.

CALLIANDRA OVATIFOLIA Engelhardt.

Calliandra ovatifolia ENGELHARDT, Sitz. Naturw. Gesell. Isis in Dresden, 1894, Abh. 1, p. 12, pl. 1, fig. 56.

Description.—Leaflets inequilateral, sessile, orbicular or broadly elliptical in outline, not much longer than wide. Apex more nearly equilateral than the base. Margins entire. Texture coriaceous. Midrib stout, curved. Secondaries numerous, thin, subparallel, diverging from the midrib at wide angles.

[1] Palaeophytologie, 1890, p. 693, fig. 5.

This species, of somewhat doubtful validity, is not represented in the present collection. It was compared by Engelhardt with the existing Brazilian species *Calliandra leptopoda* Bentham.

Genus ENTEROLOBIUM Martius.

ENTEROLOBIUM GRANDIFOLIUM Engelhardt.

Plate 15, fig. 30.

Enterolobium grandifolium ENGELHARDT, Sitz. Naturw. Gesell. Isis in Dresden, 1894, Abh. 1, p. 12, pl. 1, fig. 60.

Description.—Leaflets sessile, falcate-lanceolate in outline, with a shortly acuminate inequilateral tip and a bluntly pointed very inequilateral base. Margins entire. Texture subcoriaceous. Length about 1.6 cm. Maximum width, midway between the apex and the base, about 4 mm., one-fourth on one side of the midrib and three-fourths on the opposite side. Midrib mediumly stout, curved. Secondaries mostly obsolete by immersion, a few subparallel with the lower lateral margins and camptodrome are made out with difficulty.

The present species is not common in the collections. It is very similar to the existing *Enterolobium timbouva* Martius, a Brazilian species ranging northward to the West Indies, and recorded by Herzog[1] from the hill country of Velasco, in eastern Bolivia. The genus is a small one closely related to *Inga* and *Pithecolobium*, with about half a dozen known existing species of trees with even pinnate small leaves, confined to tropical America and found from the West Indies and Central America to Brazil. Except for the two species recorded from Potosi it is unknown in the fossil state.

Enterolobium grandifolium is readily distinguished from the associated small, falcate, slightly petiolulate, *Enterolobium parvifolium*. It is somewhat like the broader forms referred by Engelhardt to *Acacia uninervifolia* as well as similar to *Mimosites engelhardti* Berry and *Machaerium eriocarpoides* Engelhardt. It is, however, somewhat larger than these, falcate and much more inequilateral.

ENTEROLOBIUM PARVIFOLIUM Engelhardt.

Plate 15, fig. 31.

Enterolobium parvifolium ENGELHARDT, Sitz. Naturw. Gesell. Isis in Dresden, 1894, Abh. 1, p. 12, pl. 1, fig. 61.

Description.—Leaflets slightly petiolulate, linear falcate, inequilateral. Apex bluntly pointed to slightly cuspidate, slightly inequilateral. Base inequilaterally pointed. Margins entire. Texture coriaceous. Length ranging from 1 to 1.5 cm. Maximum width, in the middle part of the leaflet, about 2.5 mm. Midrib stout, curved. Secondaries obsolete, a few camptodrome ones diverging at wide angles occasionally seen.

[1]Herzog, Th., Pflanzenformationen Ost Bolivias, Englers Bot. Jahrb., vol. 44, 1910.

This species, represented by several specimens from Potosi, is much smaller, more falcate, and relatively more slender than the associated *Enterolobium grandifolium* Engelhardt. Among the associated forms it approaches closest to *Machaerium eriocarpoides* Engelhardt, in which, however, the leaflets are straighter, relatively wider, lanceolate instead of linear, the petiolule is longer, and the secondaries are less obsolete and more ascending.

Enterolobium parvifolium may be compared with the existing *Enterolobium schomburgkii* Bentham, which ranges from Panama to Brazil, and which it greatly resembles. I have figured an excessively falcate leaflet, the majority are less falcate and more like the specimen figured by Engelhardt.[1]

Plesiotype.—Cat. No. 35093, U.S.N.M.

Family CAESALPINIACEAE.

Genus CASSIA Linnaeus.

CASSIA SINGEWALDI, new species.

Plate 15, figs. 32–34.

Cassia chrysocarpoides Britton (not Engelhardt), Trans. Amer. Inst. Mining Eng., vol. 21, 1893, p. 252 (part), figs. 30–33 (not figs. 29, 34, 35).

Description.—Leaflets obovate to elliptical in outline with a broadly rounded equilateral or nearly equilateral tip and a markedly inequilateral base, which is somewhat variable in outline. In some leaflets one margin narrows almost straightly, while the other is broadly rounded; in others both margins are full and that on one side resembles half of the base of a cordate leaflet: and every gradation between these two extremes are present. Margins entire, generally slightly undulate. The leaf substance is not thick, but the leaflets appear stiff and subcoriaceous in texture. A short expanded petiolule is present in some of the leaflets that it has not been found possible to differentiate from this species by means of any other characters, but the majority are sessile with an expanded base of the midrib.

Length ranging from 3.3 to 3.5 cm. Maximum width, at or above the middle, ranging from 1.4 to 1.75 cm. Midrib stout, prominent on the underside of the leaflet. Secondaries relatively stout; about 12 pairs diverge from the midrib at angles of from 40 to 70°, being more ascending in the narrower more obovate leaflets, and less ascending in the elliptical leaflets or in the fuller side of the leaflets. The secondaries are approximately evenly spaced and subparallel: they are for the most part rather straight in their courses and are camptodrome in the marginal region. The tertiaries are thin, but well marked, as shown in the figures, forming an open polygonal or often

[1] Sitz. Naturw. Gesell. Isis in Dresden, 1894, Abh. 1, p. 12, pl. 1, fig. 61.

nearly rectangular areolation. The leaflets have the appearance of having had a glaucous surface, but this may be due to their preservation.

This species is based upon material collected by Singewald and Miller and on certain of the leaflets figured by Britton and referred to *Cassia chrysocarpoides* Engelhardt. Of the latter the form with a petiolule refigured in the present connection may be of another species, but is otherwise indistinguishable. *Cassia chrysocarpoides* Engelhardt is relatively much shorter and broader with a more pointed tip and with thinner and more curved secondaries.

It is named for Dr. J. T. Singewald, jr., of the Johns Hopkins University.

Cotype.—Cat. No. 35092 U.S.N.M.

CASSIA RIGIDULIFOLIA Engelhardt.

Plate 16, fig. 1.

Cassia rigidulifolia ENGELHARDT, Sitz. Naturw. Gesell. Isis in Dresden, 1894, Abh. 1, p. 10, pl. 1, fig. 34.

Description.—Leaflets sessile, but slightly inequilateral, obovate in outline, with a retuse apex and a cuneate base. Margins entire, full and evenly rounded. Texture coriaceous. Length about 2.5 cm. Maximum width, midway between the apex and the base, about 1 cm. Midrib stout and straight, prominent. Secondaries widely spaced, stout, about six pairs diverge from the midrib at wide angles of about 55 to 60°, pursue a nearly straight course two-thirds of the distance to the margin and then arch upward in a broad camptodrome loop. Tertiaries mostly obsolete.

This species was compared by Engelhardt with the existing *Cassia mucronata* Sprengel of Brazil, and it is also much like various fossil species referred to *Cassia*. On the other hand it is much like various existing and fossil species referred to *Dalbergia*, *Gastrolobium*, etc.

CASSIA OBSCURA Engelhardt.

Cassia obscura ENGELHARDT, Sitz. Naturw. Gesell. Isis in Dresden, 1894, Abh. 1, p. 10, pl. 1, fig. 50.

Description.—Leaflets small, sessile, oval in form, with entire margins. Length, 6 mm. Maximum width, at or below the middle, about 5 mm. Apex rounded. Base obliquely inequilateral. Midrib straight. Secondaries, 4 or 5 camptodrome pairs.

This obscure form is evidently leguminous, but its affinity with *Cassia* is uncertain. It is not represented in the present collection, nor in that studied by Britton. It was compared by Engelhardt with the existing *Cassia rotundifolia* Persoon, a widespread form in tropical America which ranges from Mexico and the West Indies to Brazil.

CASSIA WENDTII Britton.

Plate 16, figs. 2–4.

Cassia wendtii Britton, Trans. Amer. Inst. Min. Eng., vol. 21, 1893, p. 254, figs. 52–58, 1893.

Description.—Leaflets slightly petiolulate, small, variable, oblong-elliptical and inequilateral in outline, broadly rounded or obtusely pointed and nearly equilateral at the apex, cuneate and generally inequilateral at the base. Margins entire. Texture subcoriaceous. Length, ranging from 1 to 2 cm. Maximum width, at or below the middle, ranging from 5 to 7 mm. Petiolule short, less than 1 mm. in length. Midrib slender. Secondaries thin, numerous, about 10 regularly spaced, camptodrome pairs.

This species is readily distinguishable from the other species of Cassia described from Potosi. It is, however, liable to be confused with *Drepanocarpus franckei* described by Engelhardt from this deposit, and it is not certain that the two are distinct. The latter is, however, more nearly elliptical and equilateral, with a more evenly rounded apex and base, and is sessile instead of petiolulate. The present species is close to various fossil and existing species of *Cassia*, *Caesalpinia*, etc.

Plesiotypes.—Cat. Nos. 35094, 35095, 35096, U.S.N.M.

CASSIA MEMBRANACEA Engelhardt.

Plate 16, figs. 5, 6.

Cassia membranacea Engelhardt, Sitz. Naturw. Gesell. Isis in Dresden, 1894, Abh. 1, p. 9, pl. 1, fig. 31, 32.

Cassia ligustrinoides Britton (not Engelhardt), Trans. Amer. Inst. Min. Eng., vol. 21, 1893, figs. 46–48 (not figs. 21–27).

Description.—Leaflets sessile, ovate in outline, generally but slightly inequilateral, bluntly pointed at both ends. Margins entire, generally full and equally rounded. Substance thin. Length ranging from 2.7 to 4 cm. Maximum width, generally midway between the apex and the base, ranging from 1 to 1.6 cm. Midrib stout, prominent. Secondaries thin, 8 to 10 pairs diverge from the midrib at angles of 45° or less and form a diminishing series of camptodrome arches subparallel with the lateral margins. Tertiaries thin, more or less percurrent and intermediates crossing to form a more or less quadrangular open areolation. A large leaflet is figured, which is abnormally inequilateral and widest above the middle.

The present species is not abundant in the collections. It was compared by Engelhardt[1] with the existing *Peltophorum vogelianium* Bentham of Brazil. Among the Potosi forms of Cassia it is closest to *Cassia chrysocarpoides* Engelhardt, differing in its more narrowly

[1] Sitz. Naturw. Gesell. Isis in Dresden, 1894, Abh. 1, p. 9.

elongated form and more pointed apex and base. It differs from *Dalbergia chartacea* Engelhardt and *Sweetia tertiaria* Engelhardt in the same particulars, and there are minor differences in the venation.

Plesiotype.—Cat. No. 35097, U.S.N.M.

CASSIA LIGUSTRINAFORMIS, new name.

Plate 16, figs. 7, 8.

Cassia ligustrinoides ENGELHARDT, Sitz. Naturw. Gesell. Isis in Dresden, 1887, Abh. 5, p. 37, pl. 1, fig. 16; 1894, Abh. 1, p. 10, pl. 1, fig. 27.—BRITTON, Trans. Amer. Inst. Min. Eng., vol. 21, 1893, p. 252, figs. 21, 22, 24, 25, 46–48, 63 (?), not figs. 23, 26, 27, 1893; (not Schrank, Denks. Akad. Muench., vol. 6, 1816, p. 179.

Description.—Leaflets sessile, inequilateral, lanceolate in outline, with a pointed nearly equilateral tip and a slightly blunter pointed, inequilateral base. Margins entire, evenly rounded. Texture subcoriaceous. Length ranging from 3.5 to 5.5 cm. Maximum width, midway between the apex and the base, ranging from 9 mm. to 1.5 cm. Midrib mediumly stout, generally curved, not especially prominent. Secondaries thin but prominent, numerous; about 10 opposite to alternate pairs diverge from the midrib at angles averaging about 45° and are camptodrome. Tertiaries thin but well marked.

This is a common and characteristic form in the Potosi collections much like numerous previously described fossil species and many still existing species of this large genus, especially the existing *Cassia ligustrina* Linnaeus after which it was named. It is also found at Corocoro. Britton has referred several forms to this species which fall beyond its limits of variation, and this is especially true of the small petiolate leaves shown in his figures 26 and 27. Engelhardt's name is preoccupied by Schrank, 1816. *Cassia* is abundant and varied at Potosi being represented by no less than 10 species. *Cassia chrysocarpoides* Engelhardt is much shorter and wider, *Cassia cristoides* Engelhardt is a much smaller spatulate form, *Cassia wendtii* Britton is very much smaller and oblong elliptical in form, *Cassia singewaldi* Berry is a broadly elliptical form. *Cassia rigidulifolia* Engelhardt is a large retuse form, *Cassia obscura* Engelhardt is a very small obscure form, and *Cassia membranacea* is very similar to the present species, but with slightly wider thinner leaves with more numerous secondaries.

Plesiotypes.—Cat. Nos. 35135, 35136, U.S.N.M.

CASSIA CULTRIFOLIAFORMIS, new species.

Plate 16, fig. 9.

Description.—Leaves bifoliate. Leaflets inequilateral obovate, coriaceous, with a widely rounded apex and a gradually narrowed sessile base. Margins entire. Texture coriaceous. Length about 1 cm. Maximum width, above the middle, about 4 to 5 mm. The upper margin is nearly straight, the outer margin is full and rounded.

Venation thin; several fine primaries diverge from the base at acute angles and take a subparallel course, forking at intervals and frequently inosculating to form narrow elongate meshes that give the leaflet the appearance of close set parallel veins, ultimate loops camptodrome along the margin.

This handsome and well-marked species is scarcely to be distinguished from the existing *Cassia cultrifolia* Humboldt, Bonpland, and Kunth of the northern South American Tropics, differing merely in the character of the base, which is narrowly cuneate instead of equilateral. It may also be compared with the existing *Cassia bifoliolata* with which the differences are more obvious. It is also very similar to the existing *Acacia crassifolia* A. Gray, but smaller and less expanded.

Holotype.—Cat. No. 35098, U.S.N.M.

CASSIA CRISTOIDES Engelhardt.

Plate 16, figs. 10, 11.

Cassia cristoides ENGELHARDT, Sitz. Naturw. Gesell. Isis in Dresden, 1887, Abh. 5, p. 37, pl. 1, fig. 13.—BRITTON, Trans. Amer. Inst. Min. Eng., vol. 21, 1893, p. 252, figs. 40–43 (not fig. 44).

Description.—Leaflets sessile, but slightly inequilateral, elongate obovate in outline, with a broadly rounded or slightly emarginate apex and a cuneate base. Margins entire. Texture subcoriaceous. Length ranging from 2.5 to 3 cm. Maximum width, in the middle part of the leaflet, ranging from 8 to 11 mm. Midrib stout and prominent. Secondaries thin, numerous, ascending, camptodrome; eight or nine subopposite to alternate pairs diverge from the midrib at regular intervals at angles of about 45° and sweep upward subparallel.

This species is comparable with the existing *Cassia crista* Jacquin which ranges from the West Indies and Central America to Brazil. Except for the truncated or emarginate apex it is much like the associated *Cassia wendtii* Britton. It belongs to the same group of leaflets as *Cassia ligustrinaformis* Berry, *Cassia singewaldi* Berry, *Cassia membranacea* Engelhardt and *Cassia chrysocarpoides* Engelhardt. The emarginate forms are much like the retuse *Cassia rigidulifolia* Engelhardt in outline but differ strikingly in venation. It is also much like *Platypodium potosianum* Engelhardt in form, but larger and sessile instead of petiolulate.

CASSIA CHRYSOCARPOIDES Engelhardt.

Plate 16, figs. 12, 13.

Cassia chrysocarpoides ENGELHARDT, Sitz. Naturw. Gesell. Isis in Dresden, 1887, Abh. 5, p. 37, pl. 1, fig. 15; 1894, Abh. 1, p. 9, pl. 1, fig. 30.—BRITTON, Trans. Amer. Inst. Min. Eng., vol. 21, 1893, p. 252, figs. 29, 34, 35 (not figs. 30–33).

Description.—Leaflets sessile or short petiolulate, slightly oval or ovate in form, the two ends nearly equally rounded, the apex slightly

more so and at times the lamina is slightly narrowed distad. Margins entire, full and evenly rounded, the lamina on one side about 1 mm. wider than on the opposite side. Texture subcoriaceous. Length about 2.8 cm. Maximum width, midway between the apex and the base, about 1.6 cm. Petiolule when present stout, about 1.5 mm. long. Midrib rather stout and prominent, nearly straight. Secondaries regularly spaced, subopposite to alternate; about 10 pairs diverge from the midrib at angles of about 45° to 50°, curve regularly upward in a subparallel manner and are camptodrome. Tertiaries thin, arched in the marginal region and largely percurrent internally. Areolation indistinct.

This well marked species is sparingly represented in the present collections but appears to have been abundant in some of the earlier collections. It is very close to the existing *Cassia chrysocarpa* Desveaux of Brazil and Guiana. Among the numerous fossil species of *Cassia* described from Potosi the only one liable to be confused with the present species is *Cassia membranacea* Engelhardt, a thinner, narrower, more elongated and more pointed form. Similar species in other genera are *Dalbergia chartacea* Engelhardt, which is narrower, more elongated, and more pointed, and *Sweetia tertiaria* Engelhardt, which is more narrowed distad and with more numerous straighter secondaries.

Plesiotype.—Cat. No. 35099, U.S.N.M.

CASSIA FRANCKEI (Engelhardt).

Phyllites franckei ENGLEHARDT, Sitz. Naturw. Gesell. Isis in Dresden, 1887, Abh. 5, p. 38, pl. 1, fig. 12; 1894, Abh. 1, p. 13.—BRITTON, Trans. Amer. Inst. Min. Eng., vol. 21, 1893, p. 258, fig. 61.

Description.—Leaflets sessile, lanceolate in outline, falcate, with an acute apex and a cuneate base. Margins dentate, entire toward the base. Length about 5.5 cm. Maximum width, at or below the middle, about 1.4 cm. Midrib stout, curved. Secondaries numerous, thin, ascending, camptodrome.

This species was based upon incomplete material described from Potosi by Engelhardt and not represented in the other collections. Engelhardt referred it to the noncommital form-genus Phyllites, but called attention to its resemblance to the existing *Cassia dentata* Vogel of the Brazilian tropics. This resemblance is so very great that I have ventured to refer this form to the genus *Cassia*.

Genus CAESALPINIA Linnaeus.

CAESALPINIA GMEHLINGI Engelhardt.

Plate 16, fig. 14.

Caesalpinia gmehlingi ENGLEHARDT, Sitz. Naturw. Gesell. Isis in Dresden, 1894, Abh. 1, p. 9, pl. 1, fig. 29.

Description.—An elliptical sessile leaflet, nearly equilateral, with entire margins. Length about 1.4 cm. Maximum width, in the

middle part of the leaflet, about 9 mm. Midrib thin. Secondaries about 6, subopposite, camptodrome pairs diverging from the midrib at wide angles.

This species is not represented in the present collections. It was compared by Engelhardt with the wide ranging existing species *Caesalpinia pulcherrima* Swartz, which extends from the West Indies and Mexico to Brazil and is also recorded from the Galapagos and Sandwich Islands.

Among the Potosi species the present is very similar in size, outline, and venation to the more elliptical leaflets of *Cassia chrysocarpoides* Engelhardt.

CAESALPINIA SESSILIFOLIOIDES, new species.

Plate 16, fig. 15.

Description.—Leaflets small, sessile, markedly inequilateral, elliptical in outline, with a rounded slightly mucronate and nearly equilateral tip and a broadly rounded inequilateral base. Margins entire, full, and evenly rounded. Leaf substance thin but firm. Length, about 4 mm. Maximum width, midway between the apex and the base, about 2.75 mm. Midrib thin, conspicuously expanded at the extreme base. Secondaries thin, ascending, camptodrome, 5 on the narrower side of the leaflet and 7 on the broader side. The latter side 40 to 50 per cent wider than the opposite side.

This well-marked species is represented by but a single specimen and there is thus no opportunity of ascertaining its limits of variation. It is almost identical in character with the leaflets of the existing *Caesalpinia sessilifolia* of Central America or *Caesalpinia microphylla* De Candolle of the Brazilian region. It may also be compared with the tropical American *Cassia rotundifolia* Persoon.

Holotype.—Cat. No. 35127, U.S.N.M.

Genus CAESALPINITES Saporta.

CAESALPINITES POTOSIANUS, new species.

Plate 16, fig. 16.

Description.—Leaflets petiolulate, small, nearly equilateral, oblong-lanceolate in outline, with a rapidly narrowed and bluntly pointed apex and a rounded base. Margins entire. Texture coriaceous. Length ranging from 6 to 8 mm. Maximum width, in the middle part of the leaflet, 1.5 to 2 mm. Petiolule stout, curved, about 0.5 mm. in length. Midrib thin, not prominent. Secondaries obsolete by immersion in the substance of the leaflet.

This species is represented by several specimens, which on account of the obsolete venation are referred to the form genus *Caesalpinites* for generically indeterminate leaflets of the Caesalpiniaceae. These

leaflets suggest a variety of existing Leguminosae and might with equal propriety be referred to the form genus *Mimosites* of the Mimosaceae. I have been influenced in referring them to *Caesalpinites* by the great abundance of Caesalpiniaceae in the Potosi flora and by their equal predominance in the existing flora of the Amazon Basin, with which the Potosi flora shows so much similarity and from which it appears to have been derived.

There are a number of other species in the Potosi flora that greatly resemble the present one. Among these I might mention the superficially identical *Calliandra obliqua* Engelhardt, which, however, is more pointed, sessile, with a very obliquely inequilateral base and several digitate primaries. *Mimosa arcuatifolia* Engelhardt is identical in form but smaller and sessile. *Enterolobium parvifolium* Engelhardt is larger, relatively narrower, more elongate, more pointed at both ends and prevailingly falcate. *Machaerium eriocarpoides* Engelhardt is larger and stouter, more pointed at both ends, and with a well-marked secondary venation. *Enterolobium grandifolium* Engelhardt is also much larger and stouter, more lanceolate, sessile, and very inequilateral, so that there is no doubt that *Caesalpinites potosianus* represents a distinct leguminous species.

Holotype.—Cat. No. 35100, U.S.N.M.

Genus COPAIFERA Linnaeus.

COPAIFERA POTOSIANA, new species.

Plate 16, fig. 17.

Description.—Leaflets sessile, inequilaterally trapezoidal in outline, bluntly pointed at both ends. Length, about 1.75 cm. Maximum width, midway between the apex and the base, about 8 mm. Margins entire. Texture coriaceous. Midrib stout, curved, prominent on the lower surface of the leaflets. Secondaries numerous, thin, mostly immersed, ascending, camptodrome. Tertiaries obsolete by immersion.

The present species is somewhat suggestive of *Pithecolobium* as well as some of the smaller leafed species of *Inga*, as, for example, *Inga trapezifolia* De Candolle, but the venation is somewhat different. The fossil leaflets, which are not uncommon at Potosi, are similar to those of the existing *Copaifera trapezifolia* Hayne, and are not unlike those of *Copaifera langsdorffii* Desfontaines of the Amazon basin, which is recorded from near Mapiri, Bolivia.

The genus *Copaifera* comprises about 16 existing species of the equatorial region of Africa and America, ranging from the West Indies to the Amazon basin in the latter region. Four of the species are African and the balance are American. A number of fossil species, based for the most part upon the characteristic pods, have

been described. The genus is present in the early Tertiary of Chile [1] and during the middle Eocene it extended northward as far as Texas,[2] and was present in the Mediterranean region of Europe in the Oligocene and Miocene.

A pod of a species of Copaifera, possibly belonging to the same species which furnished the leaflets upon which *Copaifera potosiana* is based, are represented at Corocoro, Bolivia.

Holotype.—Cat. No. 35137, U.S.N.M.

COPAIFERA COROCORIANA, new species.

Plate 16, fig. 18.

Description.—Pod of small size, nearly orbicular in outline, greatly compressed, pedunculate, obliquely cuspidate tipped, single seeded. Length, about 1 cm. from the top of the recurved cuspidate tip to the top of the peduncle. Horizontal diameter, about 8 mm. Peduncle stout, about 4 mm. long. Seed lenticular, nearly orbicular, compressed, about 4 mm. in diameter. Pod tardily, if at all, dehiscent; its surface minutely wrinkled.

The present species is somewhat smaller than the normal size of the pods in the existing species which I have seen, and it is also smaller than those of the described fossil species. It may represent the fruit of the same tree as the leaflets from Potosi described as *Copaifera potosiana*.

Holotype.—Cat. No. 35141, U.S.N.M.

Genus BAUHINIA Linnaeus.

BAUHINIA POTOSIANA, new species.

Plate 17, figs. 1, 2.

Description.—Leaves small, bifoliate. Leaflets unsymmetrical oblanceolate or obovate, 2.1 cm. in length by 5.5 mm. in maximum width. Margins entire. Leaf-substance thin. The stout slightly upward curved midrib forms the distal margin of the leaflet, only the outside part of the lamina being developed. The latter is full and evenly rounded. The apex is unsymmetrically rounded and the base is cuneate. The midrib [3] gives rise to three secondaries which diverge at acute angles and are subparallel both with each other and with the margin of the leaflet. The lowest is thin and parallel with the margin, close to which it arches from tip to tip of outwardly directed tertiaries from the second secondary. The latter, which is much stouter than the other two, traverses the median portion of the lamina, parallel to and somewhat nearer to the margin than to the midrib. It forks twice or thrice, sending off subordinate veins at acute angles, which form elongated camptodrome loops.

[1] Engelhardt, H., Abh. Senck. Naturf. Gesell., vol. 16, 1891, pt. 4, p. 681, pl. 5, fig. 8; pl. 7, fig. 4.

[2] Berry, E. W., Torreya, vol. 15, 1915, pp. 41–44, fig. 5.

[3] This is probably morphologically an upper secondary, the true midrib being obsolete.

The tertiaries form elongated meshes, all of which in the upper half of the leaflet are arched distad and pointed proximad.

This characteristic form bears some resemblance to certain leaflets of *Acacia* and *Calliandra*, as well as to the leaflets of some species of *Cassia*, as, for example, the South American *Cassia cultrifolia* Humboldt, Bonpland, and Kunth. While the form is not distinctive, the venation is typically that of *Bauhinia*, to which genus I have referred it. It is smaller than, perhaps, the majority of existing species of *Bauhinia*, but there are a number that resemble it closely in size both among recent species, as, for example, *Bauhinia uniflora*, and among fossil species, as, for example, *Bauhinia marylandica* Berry.

This remarkable genus, abundantly represented by butterflylike leaves in the Upper Cretaceous of North America, comprises upward of 200 existing species of trees or high-climbing shrubs widely distributed in the Tropics of both hemispheres. About 40 per cent of the recent species are American, where they range from the West Indies and Mexico to southern Brazil. South America contains more species than any other continent, although both Africa and Asia have numerous species. *Bauhinia* is common in eastern Bolivia, but does not, as far as I know, occur farther west than the well-watered subandean eastern slope of the Cordillera, although a small-leafed species, *Bauhinia microphylla*, is present in the thornbush country or Gran Chaco region.

Cotypes.—Cat. Nos. 35101, 35102, U.S.N.M.

Genus PELTOPHORUM Vogel.

PELTOPHORUM MEMBRANACEUM Engelhardt.

Plate 17, fig. 3.

Peltophorum membranaceum ENGELHARDT, Sitz. Naturw. Gesell. Isis in Dresden, 1894, Abh. 1, p. 9, pl. 1, fig. 47.

Description.—Leaflets small, sessile, inequilateral, ovate in general outline, with a bluntly pointed apex and an obliquely cuneate base. Margins entire. Length, about 8 mm. Maximum width, in the middle part, about 3.5 mm., one side one-third wider than the other. Midrib mediumly stout, curved proximad. Secondaries thin, about three ascending camptodrome pairs.

This species was described from Potosi by Engelhardt, and is not present in the other collections from Bolivia. The peculiar outline serves to readily distinguish it from the other members of the Potosi flora. It has been compared with the existing *Peltophorum vogelianum* Bentham of the Brazilian region.

The genus *Peltophorum*, not otherwise known in the fossil state, comprises about eight species of trees common to the tropics of both hemispheres.

Family PAPILIONACEAE.

Genus AMICIA Humboldt, Bonpland, and Kunth.

AMICIA ANTIQUA Britton.

Plate 17, figs. 4, 5.

Amicia antiqua BRITTON, Trans. Amer. Inst. Min. Eng., vol. 21, 1893, p. 252, figs. 11, 45.

Description.—Leaflets sessile, narrowly or broadly cuneate in general outline, with an emarginate apex. Length ranging from 2 to 3 cm. Maximum width in the apical part of the leaflet ranging from 0.75 to 1.4 cm. Margins entire, slightly undulate. Texture coriaceous. Midrib mediumly stout, slightly flexuous, prominent on the lower surface of the leaflets. Secondaries thin, numerous, ascending, camptodrome. Tertiaries obsolete.

This species was described by Britton from a limited amount of material collected by Wendt and is not contained in the recent collection made by Singewald and Miller. It may be compared with the existing *Amicia lobbiana* Bentham found at high altitudes in the Peruvian and Bolivian Andes (1,800–3,000 meters).

The genus *Amicia*, not otherwise known fossil, comprises five or six species of shrubs or undershrubs of the Andean region, ranging from Mexico to Bolivia.

The identification of the present species is somewhat questionable upon general grounds, for while the fossil agrees with the existing leaflets of *Amicia*, and it is quite natural to identify the fossil leaflets with a recent genus of the same general region, the fact that the vast majority of the fossil forms found at Potosi are related to existing forms of the more humid regions of eastern Bolivia and the Amazon Basin, raises the question whether the present leaflets may not be more properly referable to some other leguminous genus with similar leaflets, such as would more naturally be expected to occur under such conditions and in such an association, as, for example, the genus *Dalbergia*.

Genus MACHAERIUM Persoon.

MACHAERIUM ERIOCARPOIDES Engelhardt.

Plate 17, fig. 6.

Machaerium eriocarpoides ENGELHARDT, Sitz. Naturw. Gesell. Isis. in Dresden, 1894, Abh. 1, p. 8, pl. 1, fig. 28.

Description.—Leaflets petiolulate, lanceolate in outline, nearly equilateral, with an equally pointed apex and base. Margins entire. Texture subcoriaceous. Length, 1.2 to 1.4 cm. Maximum width, midway between the apex and the base, 2.5 to 3.25 mm. Petiolule stout, 0.5 to 1 mm long. Midrib stout. Secondaries thin, regularly

spaced, subparallel; six or seven pairs diverge from the midrib at angles of about 45° and are camptodrome. Tertiaries obsolete by immersion.

This species is not uncommon in the present collection. While similar to several other fossil species found at Potosi, it may be distinguished from *Acacia uninervifolia* Engelhardt by its petiolule, greater width and fewer secondaries; from *Enterolobium grandifolium* Engelhardt by its petiolule, its smaller size, more prominent secondaries and more equilateral form; from *Mimosites engelhardti* Berry by its wider, less elongated, and more lanceolate form, by its petiolule and more prominent secondaries. According to Engelhardt it is very similar to the existing Brazilian species *Machaerium criocarpum* Bentham. This species is recorded by Herzog [1] from the hill country of Velasco and from the broken woods along the Rio Pirai and Rio Yapacani, in eastern Bolivia.

The existing species of *Machaerium* comprise over 60 trees or high climbing shrubs, with small pinnate leaves, confined to the American Tropics, where they range from the West Indies and Central America to southern Brazil. Their maximum display is in the Amazon region, and they do not appear to be represented in the present mountain region of Bolivia.

The known fossil species are few in number and comprise, in addition to the present form, three Oligocene and a Miocene species in central and southern Europe.

Plesiotype.—Cat. No. 35103, U.S.N.M.

MACHAERIUM MILLERI, new species.

Plate 17, fig. 7.

Description.—Leaflets petiolulate, oblong-obovate, nearly equilateral, with a broadly rounded apex and a cuneate base. Margins entire. Texture subcoriaceous. Length about 2 cm. Maximum width, at or slightly above the middle, about 7 mm. Petiolule stout, curved, 2 to 2.5 mm in length. Midrib stout, curved. Secondaries thin, numerous; they diverge from the midrib at angles of about 45° and pursue a nearly straight ascending course, forking and anastomosing, and eventually lost in the camptodrome areolation of the marginal region.

This well-marked form suggests comparisons with various existing species of *Leptolobium* and *Platypodium*, both of which are represented in the Potosi flora. The venation, however, appears to ally it more closely with the reticulate veined species of *Machaerium*. It is readily distinguished from the associated *Machaerium criocarpoides* Engelhardt, which is a lanceolate leaflet with relatively distant and regularly curved camptodrome secondaries. Among other forms

[1] Herzog, Th., Pflanzenformationen Ost Bolivias, Englers Bot. Jahrb., vol. 44, 1910.

from Potosi there is some resemblance to *Platypodium potosianum* Engelhardt, which is about the same size but generally wider with fewer regularly curved camptodrome secondaries. There is also a more distant resemblance to *Cassia wendtii* Britton, which is more inequilateral, with a shorter petiolule, fewer and better marked camptodrome secondaries, generally more pointed tip and widest below the middle. Named for the collector, Prof. B. L. Miller, of Lehigh University.

Holotype.—Cat. No. 35104, U.S.N.M.

Genus DALBERGIA Linnaeus (son).

DALBERGIA POTOSIANA, new species.

Plate 17, fig. 8.

Description.—Leaflets sessile, obovate in general outline, with a broadly rounded deeply emarginate apex and a broadly cuneate base. Margins full, entire. Leaf substance thin but firm. Length, about 1.5 cm. Maximum width, above the middle, about 5 mm. Midrib very stout, curved. Secondaries very thin, about three to five camptodrome pairs. Tertiaries mostly obsolete. Areolation fine, its details obscure.

This well-marked species is clearly distinct from the other members of the Potosi flora and not close to *Dalbergia chartacea* Engelhardt, which has larger, ovate leaflets. It is very similar to a large number of existing and fossil species of *Dalbergia*, to which a large number of fossil leaflets and pods have been referred. A pod from Potosi is referred to this genus by Engelhardt, but its determination is not above suspicion.

The existing species of *Dalbergia* number about 80 forms, occurring in both the Oriental and Occidental Tropics. There are a large number of species in the Amazon Basin.

Holotype.—Cat. No. 35105, U.S.N.M.

DALGERGIA CHARTACEA Engelhardt.

Dalbergia chartacea ENGELHARDT, Sitz. Naturw. Gesell. Isis in Dresden, 1894, Abh. 1, p. 8, pl. 1, fig. 25.

Description.—Leaflets ovate, bluntly pointed at the apex, with a broadly cuneate base, nearly equilateral, with full and evenly rounded entire margins. Texture coriaceous. Length, about 2.5 cm. Maximum width, midway between the apex and the base, about 11 mm. Midrib straight and mediumly stout. Secondaries thin; about six pairs diverge from the midrib at angles of about 45°; they range from opposite to alternate and pursue a subparallel camptodrome course. Tertiaries mostly obsolete.

This somewhat doubtfully determined form is not represented in the present collections. It was compared by Engelhardt with the

existing *Dalbergia variabilis* Vogel of tropical Peru, Guiana, and Brazil. In both outline and venation the present leaflets are distinguished with difficulty from those of the associated species *Cassia membranacea* Engelhardt and *Sweetia tertiaria* Engelhardt. The first are slightly narrower and more elongate, and the last, while similar in size and outline, are slightly broader with straighter, more numerous secondaries.

DALBERGIA (?) ANTIQUA Engelhardt.

Plate 17, fig. 9.

Dalbergia antiqua ENGELHARDT, Sitz. Naturw. Gesell. Isis in Dresden, 1894, Abh. 1, p. 8, pl. 1, fig. 23.

Description.—An oval pod, pointed at both ends, with a coriaceous integument and extended peduncle with a persistent calyx. About 2.5 cm. long and 1 cm. wide in the median region.

The character of this pod is more suggestive of *Cassia* than *Dalbergia*, hence I have questioned Engelhardt's generic reference. It is not represented in the present collections, but was compared by Engelhardt with the existing *Dalbergia riparia* Bentham of the Amazon Basin.

Genus DESMODIUM Desveaux.

DESMODIUM ELLIPTICUM Engelhardt.

Desmodium ellipticum ENGELHARDT, Sitz, Naturw. Gesell. Isis in Dresden, 1894, Abh. 1, p. 8, pl. 1, figs. 42–44.

Description.—Leaflets sessile or short petiolulate, elliptical in outline, slightly inequilateral. Apex and base about equally rounded. Margins entire. Length, about 9 mm. Maximum width, midway between the apex and the base, about 6 mm. Midrib slender, curved. Petiolule, when present, about 1 mm. long, stout. Secondaries thin, three or four camptodrome pairs diverging from the midrib at wide angles.

This species is not represented in the present collection. It was compared by Engelhardt with the existing *Desmodium barbatum* Bentham, which is widely distributed from the West Indies and southern Mexico to Brazil. In the existing flora *Desmodium* is a large genus with between 150 and 200 species of herbaceous and shrubby plants widely distributed in the tropics of both hemispheres and with a few extratropical species in both regions.

Genus DREPANOCARPUS Meyer.

DREPANOCARPUS FRANCKEI Engelhardt.

Plate 17, figs. 10, 11.

Drepanocarpus franckei ENGELHARDT, Sitz, Naturw. Gesell. Isis in Dresden, 1894, Abh. 1, p. 7, pl. 1, figs. 36–38.

Description.—Leaflets sessile, elliptical in outline, nearly equilateral, with a broadly rounded apex and a similarly rounded, some-

times obliquely, inequilateral base. Margins entire. Texture coriaceous. Length ranging from 10 to 13 mm. Maximum width, midway between the apex and the base, 4 to 5 mm. Midrib stout, prominent below, channeled above, relatively straight. Secondaries prominent, numerous, subparallel, camptodrome.

This species is well marked and readily distinguished from the other members of the Potosi flora. It is comparable with the existing *Drepanocarpus lunatus* Meyer, a widespread form ranging from the West Indies and southern Mexico to Brazil, and recorded also from tropical West Africa. *Drepanocarpus* is not otherwise known in the fossil state. The existing species comprise 8 to 10 trees or high climbing shrubs, all of which are confined to tropical America with the single exception noted above.

Genus AESCHYNOMENE Linnaeus.

AESCHYNOMENE BOLIVIANUM (Engelhardt).

Plate 17, fig. 12.

Hedysarum bolivianum ENGELHARDT, Sitz. Naturw. Gesell. Isis in Dresden, 1894, Abh. 1, p. 7, pl. 1, figs. 62, 63.

Description.—Leaflets small, sessile, obovate in outline, with a broadly rounded tip and an acuminate base. Margins entire. Texture membranaceous or chartaceous. Leaf substance thin. Length, about 7 mm. Maximum width, in the middle part of the leaflet, about 3.5 mm. Midrib thin, curved. Secondaries thin, numerous, equally spaced, subparallel, camptodrome.

This species was described by Engelhardt, who compared it with the existing and polymorphous *Aeschynomene falcatum* De Candolle, which ranges from Mexico to Brazil. It has not been recognized in the other collections from Potosi. I have transferred this form to the genus *Aeschynomene* with the recent species of which Engelhardt compared it and which it resembles more closely than it does *Hedysarum*. The latter is a genus with over three score existing species of herbs or shrubs of the temperate regions of Europe, Asia, Africa, and North America. The genus *Aeschynomene*, on the other hand, is confined to the tropics of both hemispheres, with numerous existing species of herbs or shrubs, well represented in the Brazilian region.

Genus SWEETIA Sprengel.

SWEETIA TERTIARIA Engelhardt.

Plate 17, fig. 13.

Sweetia tertiaria ENGELHARDT, Sitz. Naturw. Gesell. Isis in Dresden, 1887, Abh. 5, p. 38, pl. 1, fig. 11; 1894, Abh. 1, p. 9, pl. 1, fig. 26.—BRITTON, Trans. Amer. Inst. Min. Eng., vol. 21, 1893, p. 254, fig. 79.

Description.—Leaflets sessile, nearly equilateral, ovate in general outline, with a rounded or emarginate apex and a cuneate base.

Margins entire. Texture subcoriaceous. Length, ranging from 2.5 to 3.5 cm. Maximum width, in the middle part of the leaflet, ranging from 1.3 to 1.7 cm. Midrib stout and straight. Secondaries thin, numerous, camptodrome.

This species was contained in both the collections from Potosi studied by Engelhardt, but has not been recognized in the other collections. It is clearly distinct from the other members of the Potosi flora, and was compared with the existing *Sweetia elegans* Bentham, a Brazilian species. Britton's reference of this fossil to the genus *Swertia* was simply a typographic error.

The genus *Sweetia* consists of about 10 existing species of trees confined to the South American Tropics and ranging from Guiana to southern Brazil. It is not otherwise known in the fossil state.

Genus LONCHOCARPUS Humboldt, Bonpland, and Kunth.

LONCHOCARPUS OBTUSIFOLIUS Engelhardt.

Plate 17, fig. 14.

Lonchocarpus obtusifolius ENGELHARDT, Sitz. Naturw. Gesell. Isis in Dresden, 1894, Abh. 1, p. 7, pl. 1, fig. 22 (not Engelhardt, 1895).

Description.—Leaflets elliptical in outline, slightly inequilateral, narrowed from below the middle to the broadly rounded base. Margins entire. Texture subcoriaceous. Length, about 2.4 cm. Maximum width, below the middle, about 1.4 cm. Midrib thin, straight. Secondaries thin, about 5 subopposite, camptodrome pairs. A few percurrent tertiaries visible.

This species was described from Potosi by Engelhardt, who compared it with the existing *Lonchocarpus obtusus* Bentham of the Brazilian region. It is sparingly represented in the present collections. It has also been recorded by Engelhardt [1] from the Tertiary of Ecuador, although the two occurrences represent different species. It is somewhat similar to three other Potosi species of Leguminosae—namely, *Dalbergia chartacea* Engelhardt, *Sweetia tertiaria* Engelhardt, and *Cassia chrysocarpoides* Engelhardt. The first is relatively narrower and longer, widest in the middle, not narrowed distad more than proximad and more pointed; the second is also widest in the middle, not more narrowed distad than proximad and with more numerous and less ascending secondaries; the third is widest in the middle, more pointed, not more narrowed distad than proximad, and with more numerous and less ascending secondaries.

Lonchocarpus is a genus with upward of 70 existing species of trees and high climbing shrubs of the tropical regions of America, Africa, and Australia, with more than half the existing forms confined to America. Several fossil species have been recorded, includ-

[1] Engelhardt, H., Abh. Senck. Naturf. Gesell., vol. 19, p. 17, pl. 3, fig. 1, 1895.

ing one from the Tertiary of Ecuador,[1] one from the late Tertiary of New Jersey,[2] and one from the Pleistocene of Cuba.

Plesiotype.—Cat. No. 35106, U.S.N.M.

Genus PLATYPODIUM Vogel.

PLATYPODIUM POTOSIANUM Engelhardt.

Plate 17, figs. 15–17.

Platypodium potosianum ENGELHARDT, Sitz. Naturw. Gesell. Isis in Dresden, 1894, Abh. 1, p. 12, pl. 1, fig. 41.

Cassia cristoides BRITTON (not Engelhardt), Trans. Amer. Inst. Min. Eng., vol. 21, 1903, fig. 44, (not figs. 40–43).

Cassia chrysocarpoides BRITTON (not Engelhardt), Trans. Amer. Inst. Min. Eng., vol. 21, 1893, fig. 37 (not figs. 29–36).

Description.—Leaflets petiolulate, oblong elliptical to oblong-obovate, with a nearly equilateral broadly rounded to very slightly emarginate apex and a slightly narrowed rounded or bluntly pointed considerably inequilateral base. Margins entire. Texture subcoriaceous. Length, ranging from 1.3 to 1.8 cm. Maximum width, at or somewhat above the middle, ranging from 7 to 8 mm. Petiolule stout, curved, about 2 mm. in length. Midrib relatively stout and prominent. Secondaries numerous, well marked, subparallel, camptodrome; seven to nine pairs diverge from the midrib at angles of about 45°. Tertiaries mostly obsolete except for ascending subordinates between and subparallel with the secondaries.

The present species is very close to the existing *Platypodium elegans* Vogel, which ranges from Panama to Brazil and eastern Bolivia. It resembles somewhat the smaller leaflets of *Cassia cristoides* Engelhardt *Cassia chrysocarpoides* Engelhardt and is about the same size as *Cassia wendtii* Britton. The latter, is, however, nearly sessile and pointed at both ends.

The genus *Platypodium* is not otherwise known in the fossil state. The existing species are few in number and comprise trees with even or odd pinnate small leaves confined to the Southern American Tropics and chiefly developed in the Amazon and Orinoco basins.

Plesiotype.—Cat. No. 35107, U.S.N.M.

LEGUMINOSAE INCERTAE SEDIS.

Genus LEGUMINOSITES Bowerbank.

LEGUMINOSITES (?) GLOBULARIS Engelhardt.

Leguminosites (?) *globularis* ENGELHARDT, Sitz. Naturw. Gesell. Isis in Dresden, 1894, Abh. 1, p. 13, pl. 1, fig. 59.

Description.—A globular seed about 4 mm. in diameter, referred tentatively to the Leguminosae by Engelhardt and not contained in the other collections from Potosi.

[1] Engelhardt, Abh. Senck. Naturf. Gesell., vol. 19, p. 17, 1895.

[2] Hollick, A., Bull. Torrey Bot. Club, vol. 23, 1896, p. 49, pl. 259, figs. 6–8.

LEGUMINOSITES, species.

Plate 18, fig. 1.

Description.—A small leguminous leaflet, ovate in form, with a rounded tip and greatly inequilateral base. Margin entire. Length, about 3 mm. Maximum width about 1 mm. Midrib stout and curved. A stout ascending secondary from its base on each side gives the leaflet a triveined appearance. Distad there are two pairs of thin camptodrome secondaries.

This may be a distinct species. As it is represented by only a single specimen, it is not considered wise to make it the basis of a new species, especially as it may represent a variant of the abundant *Calliandra obliqua* Engelhardt.

Holotype.—Cat. No. 35108, U.S.N.M.

Order GERANIALES.

Family ZYGOPHYLLACEAE.

Genus PORLIERIA Ruiz and Pavon.

PORLIERIA TERTIARIA Britton.

Plate 18, figs. 2, 3.

Porlieria tertiaria Britton, Trans. Amer. Inst. Min. Eng., vol. 21, 1893, p. 251, figs. 71–75.

Mimosites, species, Engelhardt, Sitz. Naturw. Gesell. Isis in Dresden, 1894, Abh. 1, p. 11, pl. 1, figs. 48, 49.

Description.—Leaves opposite, subsessile, evenly pinnate in my specimens, but odd pinnate in the type material. General outline elliptical or obovate. Length, ranging from 6 to 9 mm. Maximum width, at or above the middle, 3 to 5 mm. Leaflets sessile by a but slightly narrowed base, 8 or 9 subopposite to alternate pairs with sometimes an odd terminal leaflet, crowded especially distad, diverging at narrow angles both proximad and distad, especially one or two distal pairs. In the middle part of the leaf the angle of divergence ranges from 45 to 60°. Rachis relatively very stout. Texture coriaceous. Leaflets linear oblong or slightly spatulate, with a slightly narrowed, broadly sessile base and a rounded apex, slightly inequilateral. Margins entire. Midribs thin and immersed. Length, ranging from 1 to 2.5 mm. Maximum width one-half to one-fourth the length.

This species is not uncommon at Potosi. *Porlieria* is a small genus of shrubby plants, with three or four existing xerophytic species, found from Texas and Mexico southward to the Chilean Andes and the Argentina steppes. The fossil species greatly resembles the existing *Porlieria hygrometrica* Ruiz and Pavon of the arid country between southern Peru and northern Chile and *Porlieria lorentzii*

Engler of the Argentina steppes and eastern Bolivia plains (Santa Cruz, Cochabamba). It is one of the few fossil species found at Potosi that is clearly indicative of arid conditions, and this may be due to its having grown on a porous slope where insolation was great—i. e., it may reflect edaphic rather than climatic conditions.

The fragmentary specimens described by Engelhardt as *Mimosites*, species [1] and *Mimosa montanoides* [2] may, and probably do, represent this species.

Plesiotypes.—Cat. No. 35109, 35110, U.S.N.M.

Family EUPHORBIACEAE.

Genus EUPHORBIA Linnaeus.

EUPHORBIA (?), species, Britton.

Euphorbia (?), BRITTON, Trans. Amer. Inst. Min. Eng., vol. 21, 1903, p. 256, figs. 59, 60.

Description.—This record was based on an obscure specimen preserved in a coarser grained rock than the balance of the Potosi flora and considered by Britton to possibly represent a nodulose stem of some fleshy *Euphorbia* such as still characterize the existing flora in parts of South America. Nothing like it is contained in the collection studied by me.

Order PARIETALES.

Family PASSIFLORACEAE.

Genus PASSIFLORA Linnaeus.

PASSIFLORA CANFIELDI Britton.

Plate 18, figs. 4, 5.

Passiflora (?) *canfieldi* BRITTON, Trans. Amer. Inst. Min. Eng., vol. 21, 1893, p. 256, figs. 12, 13.

Description.—Leaves small, sessile, palmately trilobate. Margins crenulate. Texture coriaceous. Length about 1.5 cm. Maximum width, from tip to tip of the lateral lobes, about 1.4 cm. Sinuses rectangular, extending about halfway to the base. Central lobe broadly rounded distad with subparallel sides, much longer than the lateral lobes, its dimensions about 9 mm by about 5 mm, hence nearly twice as long as wide. Lateral lobes short, tending to be more narrowly rounded than the median lobe, their upper margins straighter than their lateral margins, which are full and curved to the broadly rounded base. The basal half of the leaf forms an almost exact semicircle and the crenulations of the margin become obsolete in the basal region.

[1] Engelhardt, H., Isis in Dresden, 1894, Abh. 1, p. 11, pl. 1, figs. 48, 49.
[2] Idem, p. 10, pl. 1, fig. 64.

Primaries three, stout, diverging from the extreme base at angles of about 40°, the central nearly straight and the laterals slightly curving outward, each terminating at the summit of the obtuse lobes. Tertiaries obsolete by immersion, from the character of the margin, presumably camptodrome as in the recent species.

This species is not represented in the present collection and the accompanying illustrations are reproduced from Britton's report. The latter author is doubtful of the reference of these leaves to Passiflora, but I see nothing to criticise in this determination. The marginal character and the peculiar aspect of the leaves, with their broadly rounded base, obtuse lobes, and extended oblong central lobe, and with the basal primaries stamp them clearly as referable to the Passifloriaceae, a family abundantly represented in the existing flora of South America. A number of fossil species of *Passifloria* are known, but none of these is especially close to the present species. The existing species number upward of 300 climbing shrubs or rank annuals, mostly American and tropical in their distribution, but found also in Madagascar (one species), Asia, and Australia. The present species appears to be referable to the section *Granadilla* De Candalle, which has over 80 existing species, more than half of which are Brazilian. I do not know whether or not *Passiflora* occurs at the present time in Bolivia to the west of the front range of the Andes, but it is not uncommon in eastern Bolivia, and according to Herzog [1] a species occurs in the Andean outliers of Santa Cruz and Cochabamba up to elevations of 2,600 meters.

Order MYRTALES.

Family MYRTACEAE.

Genus MYRTEOLA Berg.

MYRTEOLA POTOSIANA, new species.

Plate 18, fig. 6.

Description.—Leaves small, ovate in outline, petiolate, with entire margins and coriaceous texture. Apex acute. Base about equally acute. Length, about 13 mm. Maximum width, midway between the apex and the base, about 5 mm. Petiole stout, about 2.25 mm. in length. Midrib stout. Secondaries thin, about 1 mm. apart, diverging from the midrib at angles of between 40° and 50°, generally straightly ascending and subparallel, occasionally slightly curved, their tips joined close to the margin by a slightly arched acrodrome vein forming a marginal hem along each margin. Tertiaries indistinct, occasional fine percurrent tertiaries and acutely diverging branches from the secondaries can be discerned.

[1] Herzog, Th., Pflanzenformationen Ost Bolivias, 1910.

This little leaf is essentially myrtaceous in character and may be compared with various existing species of *Myrtus* and *Myrcia*. It shows more similarity, however to the leaves of the genus *Myrteola*, a genus of 9 or 10 species of shrubs and undershrubs closely related to *Myrtus* and now found in the existing flora in the Andean region from Ecuador to the Straits of Magellan; one species of the last region, *Myrteola nummularia* (Poiret) Berg, being also found on the Falkland Islands.

Holotype.—Cat. No. 35111, U.S.N.M.

Family COMBRETACEAE.

Genus TERMINALIA Linnaeus.

TERMINALIA ANTIQUA Britton.

Plate 18, figs. 8, 9.

Terminalia antiqua Britton, Trans. Amer. Inst. Min. Eng., vol. 21, 1893, p. 254, figs. 16, 28, 68–70.

Description.—Samaras bialate, elliptical in outline, wider than high, emarginate at the summit, cordate, truncate or decurrent to the stout peduncle. Length ranging from 1 to 2 cm. Width ranging from 1.1 to 2.5 cm. Peduncle ranging from 5 to 10 mm. in length, curved or straight. Essential part of fruit narrowly fusiform, extending upward four-fifths or all the way to the apical sinus. Wings thin, scarious. Veins numerous, thin, said by Britton to be simple but abundantly forked and anastomosing in my material.

These characteristic fruits are not uncommon at Potosi and Britton has figured a number to illustrate their variations. My material is smaller but otherwise indistinguishable, and undoubtedly belongs to the same species. On the other hand a *Terminalia* fruit collected at Corocoro, while it is bialate, is considerably larger and more coriaceous, with a large turbinate seed cavity and this I have described as a distinct species. While these Potosi fruits are suggestive of some of the Sapindaceae and average smaller than most modern winged *Terminalia* fruits, I have no hesitation in referring them to the latter genus. According to Britton [1] the present species is closely comparable to fruits of the existing *Terminalia oblonga* Persoon collected in Guatemala.

Terminalia is a large genus in the existing flora of the tropics of both hemispheres, with over 100 species about equally divided between America, Asia, Africa, and Australia. It is an old type and the modern species are segregated into four sections, based primarily on the characters of the fruit which may be fleshy, ligneous, or variously winged. So far as I know *Terminalia* is not now endemic

[1] Trans. Amer. Inst. Min. Eng., vol. 21, 1893, p. 254.

in the Andean region of Bolivia, but several species are recorded by Herzog [1] in the region of Santiago and San Jose and in the broken forests along the Rio Pirai and Rio Yapacani in eastern Bolivia.

The fossil record of *Terminalia* while very incomplete embraces about a dozen species found in both Europe and southeastern North America from the lower Eocene onward. The bulk of these, particularly those of the Mississippi embayment region, appear to have been littoral species like the modern *Terminalia catappa* and *Terminalia littoralis*.

Plesiotypes.—Cat. No. 35112, 35113, U.S.N.M.

TERMINALIA SINGEWALDI, new species.

Plate 18, fig. 7.

Description.—Samaras bialate, reniform in outline, wider than high, deeply emarginate or cordate at both the apex and the base. Peduncle stout, about as long as the vertical axis of the fruit. Length of the latter, 1.25 cm. Wings thin with entire margins. Veins thin, numerous, somewhat flexuous, frequently forking and less frequently anastomosing. Height of wings, between 2.25 and 2.5 cm. Width, about 1.25 cm. Width from margin to margin of the opposite wings, about 3.15 cm. Essential part of fruit turbinate, rounded distad, and tapering downward proximad to join the peduncle; turgid, the veins of the wings crossing its surface diagonally.

This species apparently belongs to the section Diptera of the genus. It is somewhat similar to *Terminalia antiqua* Britton, which is so common at Potosi, but differs from the latter in its larger size, in its turgid and turbinate, distally rounded seed cavity, and in its more equilateral wings with less frequently anastomosing veins. It is comparable to various two-winged modern species of Asia, Africa, and of the South American Tropics east of the Andes.

Holotype.—Cat. No. 35114, U.S.N.M.

Family LYTHRACEAE.

Genus CUPHEA P. Browne.

CUPHEA ANTIQUA Britton.

Plate 18, figs. 10–12.

Cuphea antiqua Britton, Trans. Amer. Inst. Min. Eng., vol. 21, 1893, p. 256, figs. 49–51.

Description.—Leaves small, ovate in general outline, with an acutely pointed apex, and a rounded, truncate, or cordate, inequilateral base. Margins entire. Length, 1.25 to 1.5 cm. Maximum width, in the middle part of the leaf, 6 to 9 mm. Petiole wanting.

[1] Herzog, Th., Pflanzenformationen Ost Bolivias, Englers Bot. Jahrb., vol. 44, 1910.

Midrib thin, generally somewhat curved. Normally there is a basilar or subbasilar acrodrome primary on either side diverging from the midrib at varying angles and merging with the secondary venation at or above the middle of the leaf. Sometimes a primary is developed on only one side and even when there is one on each side they are somewhat unlike in their courses since they tend to be parallel with the lateral margins of the leaf which are somewhat unsymmetric as compared with one another. There are two or three pairs of arched camptodrome secondaries above the primary or four pairs in case a primary is not developed on one side.

This species is known only from materials in the collection from Potosi studied by Britton and may therefore have been less common than the bulk of the fossil flora where the general representation runs remarkably uniform for the three collections studied.

Cuphea is a large modern genus with about 160 existing species of herbs and shrubs, otherwise unknown in the fossil state. With the exception of *Cuphea balsamona* of the Galapagos and Sandwich Islands it is confined to America and there chiefly in the equatorial and subtropical regions. *Cuphea viscosissima* Jacquin is the only North American species that extends northward beyond the Gulf States. There are over 50 species in Mexico and many extend southward along the Andes. There are 77 species in extratropical Brazil. These are several species in the moister parts of the Peruvian eastern Andes; thus *Cuphea cordata* is an under shrub which extends upward in the less arid parts of this region to elevations of 7,500 feet. The distribution of *Cuphea* in the existing flora of Bolivia is unknown, but the genus is represented in the Santa Cruz and Cochabamba regions of eastern Bolivia.

GAMOPETALAE.

Order ERICALES.

Family VACCINIACEAE.

Genus GAYLUSSACIA Humboldt, Bonpland, and Kunth.

GAYLUSSACIA TERTIARIA Engelhardt.

Gaylussacia tertiaria Engelhardt, Sitz. Naturw. Gesell. Isis in Dresden, 1894, Abh. 1, p. 6, pl. 1, figs. 8, 9.

Description.—Leaves spatulate or oblong lanceolate in outline, with an acuminate apex and a more gradually narrowed acute base. Margins entire. Texture coriaceous. Length ranging from 2.5 to 3 cm. Maximum width, in the middle part of the leaf, about 5.5 mm. Petiole missing, or absent. Midrib stout and prominent. Secondaries numerous, thin, and camptodrome.

This species was described by Engelhardt and has not been recognized in the collections from Potosi studied by me. It was compared with the existing *Gaylussacia ledifolia* Martius, a Brazilian species. *Gaylussacia* has many existing species of shrubs and undershrubs widely distributed in the Western Hemisphere from the equator well into both the North and the South Temperate Zones. The maximum of species occur in Brazil. On the other hand, the allied genera *Gaultheria* and *Vaccinium* have numerous Andean species from Central America to Chile, and the fossil species may possibly be more closely related to some of the existing species in the last two genera

Order GENTIANALES.

Family APOCYNACEAE.

Genus APOCYNOPHYLLUM Unger.

APOCYNOPHYLLUM POTOSIANUM, new species.

Plate 18, fig. 13.

Undetermined leaf, BRITTON, Trans. Amer. Inst. Min. Eng., vol. 21, 1893, p. 259, figs. 64, 67.

Description.—Leaves narrowly linear lanceolate, more or less falcate, with a gradually narrowed acuminate apex and base, presumaably sessile. Margins entire. Texture coriaceous. Midrib stout and prominent, curved, expanded proximad. Secondaries remote, diverging from the midrib at wide angles, straight to near the margin where their ends are joined by flat arches. Thin percurrent veins subparallel with the arches usually present half way between them and the midrib. Length ranging from 5 to 6 cm. Maximum width, in the middle part of the leaf, ranging from 3 to 6 mm.

Leaves of this character have been referred to the genus *Callistemon* of the Myrtaceae and to the genus *Grevillea* of the Proteaceae as well as to the form genera *Acerates* and *Apocynophyllum*. The last, established for fossil forms of the Apocynaceae of uncertain generic identity, seems to be the proper reference for these Potosi forms which are not uncommon although usually broken. The form and venation are very characteristic. Lack of sufficient recent material renders comparisons difficult. The form and particularly the venation warrant the reference of this form to the Apocynaceae which has a large number of shrubs, trees, and leaves in tropical South America. A number of genera prominent in the South American flora such as *Skytanthus*, *Aspidosperma*, *Tabernaemontana*, *Vallesia*, *Thevetia*, *Prestonia*, *Forsteronia*, *Robbia*, etc., have some species with leaves that are very similar to the fossil.

Cotypes.—Cat. No. 35115, *a*, *b*, *c*, U.S.N.M.

Order POLEMONIALES.

Family BIGNONIACEAE.

Genus JACARANDA Jussieu.

JACARANDA POTOSINA, new species.

Plate 18, fig. 14.

Description.—Leaflets small and thin, subsessile, lanceolate in outline, with a bluntly pointed apex and a narrowly cuneate base. Margins entire. Length, about 1.5 cm. Maximum width, midway between the apex and the base, about 3 mm. Petiolule very broad, short, 1 mm. or less in length, truncate. Midrib attenuated distad, broad in the lower half of the leaflet, expanding rapidly proximad to its junction with the petiolule with which it is continuous. Secondaries thin, numerous, ascending; they diverge from the midrib at acute angles subparallel with one another and the lateral margins and are connected by straight oblique tertiaries.

This well marked new form is referred with some hesitation to the genus *Jacaranda*, agreeing with the leaflets of several of the existing pinnate leafed species with tiny leaflets, as for example, *Jacaranda caroliniana* Pohl or *Jacaranda cuspidifolia* Martius.

The genus *Jacaranda* comprises about two score existing species of shrubs of the campos and trees. It is confined to tropical America and ranges from Bermuda to Brazil, and is abundant in the Amazon basin. The only other known fossil species is one based upon both leaflets and seeds described by Ettingshausen [1] which Schenk [2] thinks is of doubtful identity. There are poorly preserved specimens of several varieties of winged seeds present in the Potosi collections, but none of these can be conclusively referred to the Bignoniaceae.

According to Herzog [3] *Jacaranda cuspidifolia* occurs in the vicinity of Santiago and San Jose and in the hill country of Velasco and a second species is found in the broken woods along Rio Piraï and Rio Yapacani, all localities in eastern Bolivia.

Holotype.—Cat. No. 35116, U.S.N.M.

[1] Ettingshausen, C. von. Die tertiäre Flora von Häring in Tirol, 1855, p. 59, pl. 20, figs. 12–20.
[2] Schenk, A., Palaeophytologie, 1890, p. 779.
[3] Herzog, Th., Pflanzenformationen Ost Bolivias, vol. 44, 1910.

Order RUBIALES.

Family RUBIACEAE.

Genus RUBIACITES Weber.

RUBIACITES NUMMULARIOIDES, new species.

Plate 18, fig. 15.

Description.—Leaves small, ovate, or broadly elliptical in outline, relatively long petiolate, widest in the middle, with a somewhat narrowed rounded tip and a broadly cuneate base. Margins entire. Texture coriaceous. Length, about 4 mm. Maximum width, about 3 mm. Petiole stout, curved, about 1.5 mm. in length. Midrib stout. Secondaries thin, about three subparallel, openly camptodrome pairs. Tertiaries obsolete.

These small leaves are somewhat suggestive of some species of Celastraceae, but upon the whole their closest affinities appear to be with several existing genera of Rubiaceae, and they are consequently referred to the form genus *Rubiacites* proposed by Weber for Rubiaceous leaves of uncertain generic affinity. Ignoring the exclusively herbaceous genera comparisons may be made with various existing species of *Anisomeris* Presl, *Palicourea* Aublet, and *Coprosma* Forster. None of these genera are recorded as fossils. *Anisomeris* comprises about 25 species of shrubs ranging from Venezuela to Paraguay, but chiefly Brazilian. *Coprosma* comprises about 40 species of shrubs and small trees mostly oriental and extending from Java to New Zealand and in Oceanica to Hawaii but found also on Juan Fernandez and in Chile. *Palicourea* comprises over 100 species of shrubs confined to tropical America and ranging from Mexico and the Antilles to southern Brazil.

Holotype.—Cat. No. 35117, U.S.N.M.

Order CAMPANULALES.

Family COMPOSITAE.

Genus CYPSELITES Heer.

CYPSELITES POTOSIANUS, new species.

Plate 18, fig. 16.

Description.—A linear, cylindrical achene with a corona of pappus distad. Surface with about 10 longitudinal ribs. Length, about 3 mm. Diameter, 1.5 mm. This undoubtedly represents the fruit of some species of Compositae of uncertain generic relationship. It is represented in the collections by two good specimens and fragments of others and is referred to the form-genus *Cypselites* to which Heer has referred a variety of similar remains from the Miocene of Switzerland.

Holotype.—Cat. No. 35118, U.S.N.M.

INCERTAE SEDIS.

CARPOLITHUS ENGELHARDTI, new name.

Plate 18, fig. 17.

Carpolites ovoideus ENGELHARDT, Sitz, Naturw. Gesell. Isis in Dresden, 1894, Abh. 1, p. 13, pl. 1, fig. 58 (not Corda or Goeppert).

Description.—An elliptical lenticular seed about 9 mm. in diameter and with a smooth surface, probably representing the seed of some leguminous tree, but of uncertain generic affinity. There is a single characteristic specimen in the present collection. Engelhardt's name was used by Corda in 1841 for a Paleozoic fruit and again by Goeppert in 1845 for another Paleozoic fruit, and both have been taken up by later authors, so that the name of the Potosi form has been changed as a slight token to M. Engelhardt, its original describer.

Holotype.—Cat. No. 35119, U.S.N.M.

CARPOLITHUS, species No. 1.

Plate 18, fig. 19.

A compressed seed or fruit about 7 mm. long and 5 mm. wide with the hilum at one side and surrounded by a narrow marginal wing. Possibly referable to the Aceraceae.

Cat. No. 35121, U.S.N.M.

CARPOLITHUS, species No. 2.

Plate 18, fig. 20.

A fruit consisting of five spherical nutlets, each about 4 mm. in diameter.

Cat. No. 35122, U.S.N.M.

CARPOLITHUS, species No. 3.

Plate 18, fig. 21.

A small, obovate, somewhat compressed seed with three longitudinal oblique ridges on each face, rounded distad and pointed proximad, one margin nearly straight and the other full and rounded. About 5 mm. long and 3 mm. wide. Probably corresponds to the unnamed seed figured from Potosi by Britton in his figure 78.

Cat. No. 35138, U.S.N.M.

CARPOLITHUS, species No. 4.

Plate 18, fig. 22.

A small, somewhat compressed obovate seed longitudinally lined proximad, about 2 mm. long and 1 mm. in maximum width.

Cat. No. 35123, U.S.N.M.

CARPOLITHUS, species No. 5.

Plate 18, fig. 23.

A fruit subglobular above, with a long stout peduncle, suggestive of the Lauraceae. Length, about 7 mm. Maximum width, about 2.5 mm.

Cat. No. 35124, U.S.N.M.

ANTHOLITHUS QUINQUEPARTITA Engelhardt.

Antholithus quinquepartita ENGELHARDT, Sitz. Naturw. Gesell. Isis in Dresden, 1894, Abh. 1, p. 13, pl. 1, fig. 57.

A small five parted calyx was described under the above name by Engelhardt without any suggestion as to its botanical affinity. No specimens are present in the collections studied by me. In appearance it suggests the Anacardiaceae or Celastraceae.

SPINED STEM.

Plate 18, fig. 18.

There are such a variety of unrelated plants in the modern flora of the tropics, including ferns, various monocotyledons and numerous dicotyledons, that possess slender spined stems like the small fragment figured that it is a hopeless task to even pass them in review. As an additional element in the Potosi flora this specimen deserves to be placed on record.

Cat. No. 35120, U.S.N.M.

EXPLANATION OF PLATES.

PLATE 15.

FIG. 1. *Polystichum bolivianum* Berry.
2. *Podocarpus fossilis* Engelhardt.
3, 4. *Festuca*, species.
5. *Phragmites*, species.
6, 7. *Myrica banksioides* Engelhardt.
8. *Ruprechtia braunii* Engelhardt.
9. *Carpolithus viornaformis* Berry.
10. *Capparis multinervis* Engelhardt.
11. *Escallonia wendtii* Britton.
12. *Weinmannia brittoni* Engelhardt.
13. *Weinmannia potosina* (Britton).
14, 15. *Acacia uninervifolia* Engelhardt.
16, 17, 18. *Acacia dimidiato-cordata* Engelhardt.
19. *Inga ochseniusi* Engelhardt.
20. *Pithecolobium brittonianum* Berry.
21. *Mimosa arcuatifolia* Engelhardt.
22. *Mimosites engelhardti* Berry.
23–29. *Calliandra obliqua* Engelhardt.
30. *Enterolobium grandifolium* Engelhardt.
31. *Enterolobium parvifolium* Engelhardt.
32–34. *Cassia singewaldi* Berry.

PLATE 16.

FIG. 1. *Cassia rigidifolia* Engelhardt.
2, 3, 4. *Cassia wendtii* Britton.
5, 6. *Cassia membranacea* Engelhardt.
7, 8. *Cassia ligustrinaformis* Berry.
9. *Cassia cultrifoliaformis* Berry.
10, 11. *Cassia cristoides* Engelhardt.
12, 13. *Cassia chrysocarpoides* Engelhardt.
14. *Caesalpinia gmehlingi* Engelhardt.
15. *Caesalpinia sessilifolioides* Berry.
16. *Caesalpinites potosianus* Berry.
17. *Copaifera potosiana* Berry.
18. *Copaifera coriacoriana* Berry.

PLATE 17.

FIGS. 1, 2. *Bauhinia potosiana* Berry.
3. *Peltophorum membranaceum* Engelhardt.
4, 5. *Amicia antiqua* Britton.
6. *Machaerium eriocarpoides* Engelhardt.
7. *Machaerium milleri* Berry.
8. *Dalbergia potosiana* Berry.
9. *Dalbergia* (?) *antiqua* Engelhardt.
10, 11. *Drepanocarpus franckei* Engelhardt.
12. *Aeschynomene bolivianum* (Engelhardt).
13. *Sweetia tertiaria* Engelhardt.
14. *Lonchocarpus obtusifolius* Engelhardt.
15, 16, 17. *Platypodium potosianum* Engelhardt.

PLATE 18.

FIG. 1. *Leguminosites*, species.
2, 3. *Porlieria tertiaria* Britton.
4, 5. *Passiflora canfieldi* Britton.
6. *Myrteola potosiana* Berry.
7. *Terminalia singewaldi* Berry.
8, 9. *Terminalia antiqua* Britton.
10, 11, 12. *Cuphea antiqua* Britton.
13. *Apocynophyllum potosianum* Berry.
14. *Jacaranda potosina* Berry.
15. *Rubiacites nummularioides* Berry.
16. *Cypselites potosianus* Berry.
17. *Carpolithus engelhardti* Berry.
18. *Spined stem*.
19. *Carpolithus*, species No. 1.
20. *Carpolithus*, species No. 2.
21. *Carpolithus*, species No. 3.
22. *Carpolithus*, species No. 4.
23. *Carpolithus*, species No. 5.